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MACHINERY

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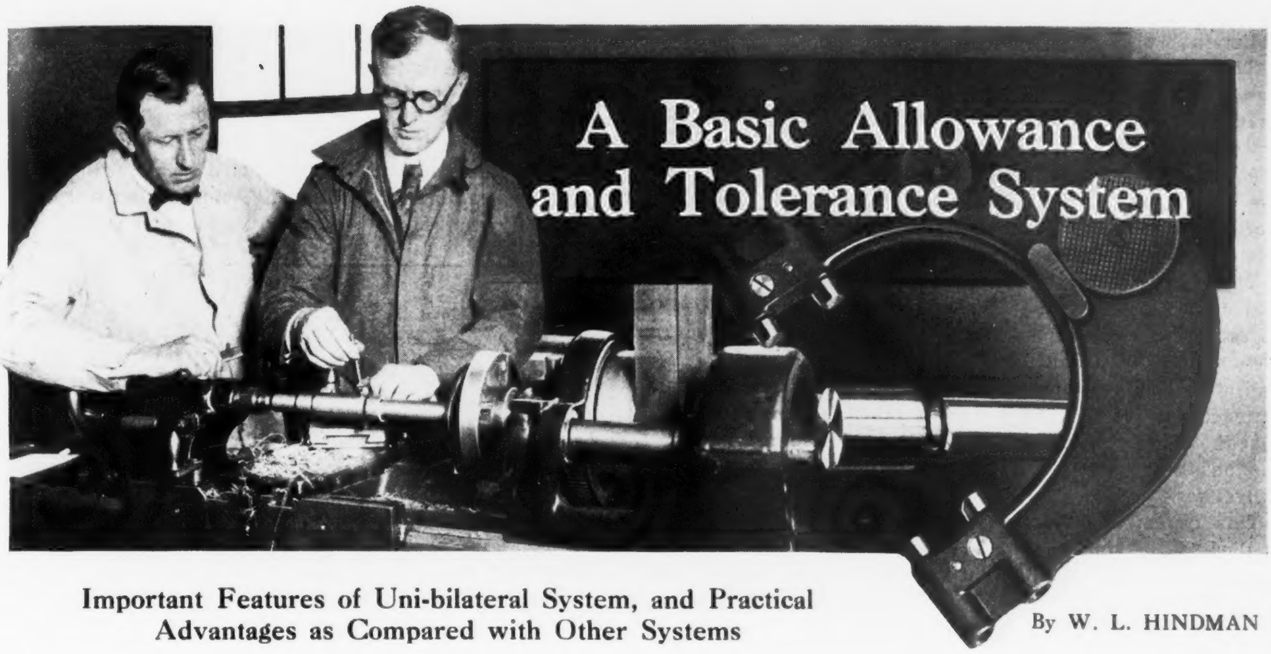

A Basic Allowance and Tolerance System

Important Features of Uni-bilateral System, and Practical Advantages as Compared with Other Systems

By W. L. HINDMAN

IN the production of various classes of mechanism according to the modern interchangeable plan of manufacture, different machine parts are given suitable tolerances and allowances to promote efficiency in manufacture, and also to obtain whatever degree of interchangeability is considered essential and the proper kinds of fits between adjacent parts. The application of this general plan of specifying and controlling the dimensions of machine parts involves first, the selection of tolerances and allowances that are based either upon judgment and experience, or upon definite knowledge as to values that will meet practical requirements. It also involves the application of some method or system of specifying upon working drawings the required dimensions, and finally, the employment of machining processes and gaging devices designed to insure the production of parts within prescribed limits of accuracy.

Since the perfection in the production of machine parts is not only impossible but unnecessary, the plan is to approach it close enough to insure proper functioning of whatever part is being made, but not so close as to increase manufacturing costs unnecessarily. To use a simple illustration, a 1-inch hole has a nominal diameter of 1 inch, but actually the diameter will be slightly larger or smaller, the total variation from the size aimed at being possibly 0.001 inch, or at most only a few thousandths inch. It is evident that the tolerances or permissible errors may vary widely for different classes of work, and also that tolerances and allowances must be related in some way to the nominal or basic sizes.

In the present article this important relationship and its possible advantages and disadvantages under manufacturing conditions will be considered, together with the application of a system developed by the writer, which is intended to simplify and standardize the use of basic tolerances and allowances, as well as methods of indicating or specifying different kinds of fits on working drawings. Before describing the important features of this system, the distinction between tolerance, allowance, and limit, according to approved usage of these terms, will be explained.

W. L. HINDMAN, author of this article, received his technical training at the Carnegie Institute of Technology, Pittsburg, Pa. He has had a broad, practical experience in the machine-building field as machinist, toolmaker, rate-setter, foreman, assistant superintendent, superintendent, tool engineer, assistant manager of engineering, and standards chief, with the Colburn Machine Tool Co., Columbus Iron Works, Westinghouse Machine Co., Westinghouse Electric & Mfg. Co., the Duff Mfg. Co., White Motor Co., and other firms. He made a general survey of the need of a practical system of tolerances while carrying on important production work with such companies as National Lamp Works, Chandler Motor Car Co., Federal Mogul Corporation, Oakland Motor Car Co., Maxwell Motor Co., Chrysler Motor Co., and Paige-Detroit Motor Car Co.

Tolerance, Allowance and Limit Defined

Tolerances represent permissible errors, the aim being to make parts accurately enough to function properly, and at the same time avoid any unnecessary precision which would increase manufacturing costs without a proportionate increase in the practical value of the parts produced. Tolerances are sometimes referred to as limits, the terms being used interchangeably, but according to approved usage, limits represent maximum and minimum dimensions, such, for example, as the maximum and minimum diameters of a hole, whereas the tolerance is the difference between these limiting dimensions, which difference represents the allowable error.

An allowance is a dimension representing either clearances or interference between adjacent parts in order to obtain a given class of fit. For example, more or less clearance space is necessary when freedom of movement is required (the amount depending upon the class of work). On the contrary, if parts must be forced together to secure a "press fit," as when a pin is pressed into a hole having a diameter slightly less than the pin diameter, positive interference between the parts is essential.

Different Methods of Applying Tolerances

If some part, such, for example, as a hole has a nominal or basic size of, say, 1 inch, it is evident that the total tolerance, according to specifications on drawings, may be (1) added to the nominal size, as at *A*, Fig. 1; (2) deducted from the nominal size, as at *B*; or (3) divided relative to the nominal size, so that part

of the tolerance is plus and part minus, as at *C* and *D*. When the total tolerance is added to or deducted from the nominal size, the system is called "unilateral," whereas when one half of the tolerance is above and the other half below the nominal size as at *C*, the system is designated as "bilateral."

The "uni-bilateral" system, developed by the writer, is so named because the tolerances for all holes are so divided that one-third of the tolerance is above and two-thirds below the nominal size, as at *D*. The ideal relationship between a nominal dimension and its tolerance is that which enables the parts to be produced to the best advantage. In other words, the relationship should depend primarily upon manufacturing rather than drafting-room practice.

This means that tolerances should be so related to nominal sizes that they tend to simplify and reduce the costs as far as possible, of machining processes and tool equipment; consequently, such important tools as reamers, gages, and other common forms of tool equipment should be taken into account. It is because of these practical considerations that the hole tolerances in the uni-bilateral system are given the one-third and two-thirds division, as explained more fully later.

This system in its entirety embraces, in addition to the method of applying tolerances, a series of tables consisting of basic allowances for different kinds of fits and corresponding tolerances for both holes and shafts. In conjunction with these tables, there is also a series of standard symbols consisting of letters and numbers, which are used to identify readily a given class of fit and indicate its accompanying allowance and tolerance data. The uni-bilateral system is an attempt to supply a consistent and universal system which may be employed the same as other universal standards. It is based on an extended study of existing systems, and has proved successful under normal manufacturing conditions.

Reasons for Dividing Tolerances as Prescribed for Uni-bilateral System

The development of the uni-bilateral system, so far as the relation of tolerances and nominal sizes is concerned, is based primarily upon four major and very important conditions, including (1) the use of new standard reamers as purchased; (2) the acceptance by the inspection department of the first holes produced with new reamers; (3) the maximum life for reamers; and (4) the use of standard jig bushings. The basic principle of the uni-bilateral system meets all of these conditions, and this system has proved satisfactory during a test of seven years under severe service conditions.

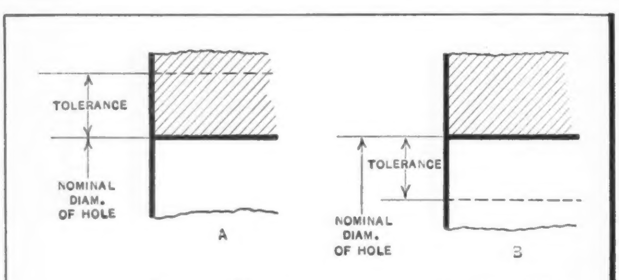

Fig. 1. Diagrams representing (A and B) Unilateral Tolerances; (C) Bilateral Tolerance; (D) Uni-bilateral Tolerance

The most common method of producing quality holes is by reaming with solid standard-size reamers, and although the uni-bilateral method of applying tolerances is intended for general use, regardless of the machining process, its particular advantages for basic reamed holes will be referred to, owing to the universal adoption and importance of this type of hole-finishing tool.

The tolerance range of standard reamers, as furnished by one of the largest reamer manufacturers in the United States, varies from + 0.0001 to + 0.0004 inch for reamers up to 1/2 inch, and from + 0.0005 to + 0.0008 inch for reamers up to 12 inches in diameter. Now if the amount of plus tolerance for a hole or the amount permitted above normal size, is such that a new standard reamer will be just within the maximum limit, it is evident that this new reamer may be used without modification and that it will have maximum life, because the gradual reduction in size through wear or sharpening must equal practically the total tolerance before the reamer is below the minimum limit. The one-third and two-thirds division of the hole tolerance in the uni-bilateral system is intended to approach, as close as possible, the ideal condition just referred to (see diagram Fig. 2).

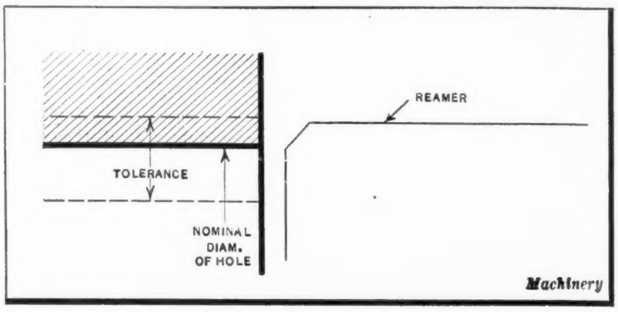

Fig. 2. Diagram showing Relation between New Standard Reamer and Hole when Tolerance is Uni-bilateral

Disadvantages of the Unilateral and Bilateral Systems as Regards Standard Reamers

In the application of the unilateral system, if all of the tolerance is plus, there are the following restrictions: First, over-size reamers are required, which are special and much more expensive than one standard reamer for each nominal size; moreover, several different over-sizes are needed for each nominal size, to provide for the various tolerances for different classes of work. Second, as soon as a reamer is even slightly under the nominal size it is useless, since it cannot longer produce holes that will pass the "Go" gage. Third, the tremendous number of existing jig bushings which have been made to fit standard reamers would have to be enlarged to accommodate over-size reamers, if the unilateral system with all the tolerance above the nominal size were adopted. Fourth, all mandrels or arbors now made for standard holes would have to be replaced.

The disadvantages in using the unilateral system when all of the tolerance is applied below the nominal size will now be considered. In the first place, a new reamer that is larger than the standard size (and practically all new reamers are) could not be used without first honing or regrinding it. Second, a new reamer that has been reduced to standard size cannot be permitted to cut over-size without spoiling the work, although it is well known that new reamers owing to their keen edges will usually ream slightly over-size for perhaps several hundred holes (depending upon the material and length of hole) before the exact size is obtained; hence, these parts will not pass the "Not Go" gage. The third disadvantage is that mandrels or arbors would have to be reground or lapped to a slightly reduced size to adapt them to the general run of holes.

If the bilateral system is employed, the hole tolerance being equally divided above and below the nominal size, more tolerance is allowed above the nominal size than is ordinarily required for a new reamer; consequently, this extra tolerance which is beyond the maximum size of holes produced by a new reamer, shortens the life of the reamer proportionately, thus increasing unnecessarily the reamer

cost per hole. All the disadvantages accompanying the use of the unilateral and bilateral systems are eliminated through the use of the uni-bilateral system.

Reamer Diameter Equals Either Nominal or Mean Diameter in Uni-bilateral System

According to the standard terms adopted for the uni-bilateral system, the "mean hole size" is a size that is one-third of the total hole tolerance less than the maximum hole size, or two-thirds of the total hole tolerance more than the minimum hole size. A "standard hole" has a mean size equal to the nominal size, and a "special hole" has a mean size that is either greater or less than the nominal size. The "nominal size" is the term commonly used in designating the size of a hole, shaft, etc., or it may be defined as the theoretical size, from which variations or tolerances are permitted.

One of the great advantages claimed for the uni-bilateral system is that either the nominal size or the mean size is always the reamer size, both for standard and special holes. To illustrate, assume that a hole of 1 inch nominal size is to have a hole tolerance of 0.0015 inch; then for a standard hole we have $1.000 {+0.0005 \atop -0.001}$; for a special hole of 0.001 inch over-size: $1.001 {+0.0005 \atop -0.001}$; for a special hole 0.001 inch under-size: $0.999 {+0.0005 \atop -0.001}$. It will be seen that the one-third and two-thirds division of the tolerance is related to the nominal size in the first instance and to the mean sizes in the second and third instances; consequently, the advantages previously mentioned regarding reamer tolerances and wear hold good whether the reamers are standard or special.

Arrangement of Basic Tables of Allowances and Tolerances

One of the extensive series of basic tables of allowances and tolerances for the uni-bilateral system is reproduced herewith (see Table 1), in order to show the arrangement, the tables all being the same general form. This table is one of a series for running fits, providing a range of allowances and tolerances suitable for different sizes and classes of work. The class of allowances represented by this particular table is designated by the general symbol A3 at the top of the table. The preceding tables in the series are Class A2, Class A1, and Class A, whereas those that follow are designated as Class A4, A5, etc. The Class A3 allowances all have a minimum allowance of — 0.0005 inch, as shown. (The minus sign preceding a dimension for allowance indicates clearance, and the plus sign, interference). The preceding tables in this series have smaller minimum allowances, and the following tables, larger minimum allowances. The minimum allowance, however, for each table is constant, but there is a selected variety of maximum allowances in each table.

In order to show how these tables are used, suppose that previous experience with a given class of work has indicated that a minimum allowance of — 0.0005 inch and a maximum allowance of — 0.003 inch is satisfactory between a shaft and a hole having a nominal size of 1 inch. The minimum allowance of — 0.0005 inch shows at once that the tolerance data will be found in the table for Class A3 allowances (Table 1).

In order to find the proper hole and shaft tolerances, the specified minimum and maximum allowances are first located in the body of the table. In this instance, we find that the maximum of — 0.003 inch is in that section of the table containing the symbol D. In the same vertical column and at the top of the table we find that ${+0.0005 \atop -0.0010}$ is given as the hole tolerance, and in the same horizontal column as symbol D, at the extreme left of the table, we find ${+0.0005 \atop -0.0005}$ given as the shaft tolerance; hence, the fit represented by this particular combination of allowances and corresponding tolerances would be expressed by the symbol A3D, in which A3 is the general table symbol and D the part indicating the allowance and tolerance data.

From this it will be apparent that if these basic tables were in general use in conjunction with such standard symbols, various classes of fits could be definitely indicated in specifications or drawings by means of these simple symbols, and the allowance and tolerance represented by a given symbol could readily be ascertained merely by referring to the basic tables.

The sizes of the hole and shaft previously referred to would appear on a drawing as follows:

For the hole, $1.000 {+0.0005 \atop -0.001}$ (A3D), and for the shaft, 0.998 ± 0.0005 (A3D).

TABLE 1. CLASS A3 ALLOWANCES—RUNNING FITS

Shaft Tolerances	Hole Tolerances					
	+ 0.0001 — 0.0002	+ 0.0002 — 9.0004	+ 0.0003 — 0.0006	+ 0.0005 — 0.0010	+ 0.0007 — 0.0014	+ 0.0010 — 0.0020
	Allowances: — 0.0005 Minimum					
+ 0.0001 — 0.0001	A — 0.0005 — 0.0010	B^1 — 0.0005 — 0.0013	C^2 — 0.0005 — 0.0016	D^3 — 0.0005 — 0.0022	E^4 — 0.0005 — 0.0028	F^5 — 0.0005 — 0.0037
+ 0.0002 — 0.0002	A_1 — 0.0005 — 0.0012	B — 0.0005 — 0.0015	C^1 — 0.0005 — 0.0018	D^2 — 0.0005 — 0.0024	E^3 — 0.0005 — 0.0030	F^4 — 0.0005 — 0.0039
+ 0.0003 — 0.0003	A_2 — 0.0005 — 0.0014	B_1 — 0.0005 — 0.0017	C — 0.0005 — 0.0020	D^1 — 0.0005 — 0 0026	E^2 — 0.0005 — 0.0032	F^3 — 0.0005 — 0.0041
+ 0.0005 — 0.0005	A_3 — 0.0005 — 0.0018	B_2 — 0.0005 — 0.0021	C_1 — 0.0005 — 0.0024	D — 0.0005 — 0.0030	E^1 — 0.0005 — 0.0036	F^2 — 0.0005 — 0.0045
+ 0.0007 — 0.0007	A_4 — 0.0005 — 0.0022	B_3 — 0.0005 — 0.0025	C_2 — 0.0005 — 0.0028	D_1 — 0.0005 — 0.0034	E — 0.0005 — 0.0040	F^1 — 0.0005 — 0.0049
+ 0.0010 — 0.0010	A_5 — 0.0005 — 0.0028	B_4 — 0.0005 — 0.0031	C_3 — 0.0005 — 0.0034	D_2 — 0.0005 — 0.0040	E_1 — 0.0005 — 0.0046	F — 0.0005 — 0.0055

Machinery

The mean shaft diameter 0.998 inch is found as follows: The maximum shaft size equals the minimum hole minus the minimum allowance, or 0.999 — 0.0005 = 0.9985 inch. Since the total shaft tolerance is 0.001, the minimum shaft diameter equals maximum shaft diameter minus 0.001, or 0.9985 — 0.001 = 0.9975. The "mean shaft size," according to the standard terms of the uni-bilateral system, is one-half of the total tolerance less than the maximum shaft size, or more than the minimum shaft size. Therefore, the mean shaft size equals, in this instance, 0.998 inch.

Advantages of Standardized Symbols for Different Kinds of Fits

There are several important advantages in identifying fits on drawings by the use of symbols, such as A3D given in connection with the foregoing example. A summary of these advantages follows: First, the symbols provide a rapid, accurate method for the designer to indicate his desires to the drafting department. These symbols facilitate the recording of important fits for use with future designs. When an investigation of any fit has to be made, only one drawing is required, that is, either the drawing showing the hole or that showing the shaft. Moreover, calculations

are not required, as the symbol in conjunction with the basic tables indicates directly the allowance and tolerance data.

Further, the use of symbols is of great assistance when fits as originally specified need to be changed. For example, assume that the fit represented by symbol A3D proves to have too small a minimum allowance, and — 0.0005 is to be added, thus making the minimum allowance — 0.001 inch. In this case, the draftsman merely changes A3D to A5D, as the table of Class A5 gives a minimum allowance of — 0.001 inch. These symbols facilitate and tend to promote the standardization of fits on similar classes of work, and also result in much saving of time due to elimination of calculations and the reading of allowance and tolerance data directly from the basic tables.

Standardized Allowances and Tolerances

The basic tables for running fits included in this system consist of a series of forty-two tables with minimum allowances varying from — 0.0001 inch up to — 0.250 inch, in conjunction with a selected variety of maximum allowances. Table 1 shows one of these tables.

For push fits there is only one table, the minimum allowance throughout being zero, and the maximum shaft being equal to the minimum hole.

TABLE 2. CLASS C ALLOWANCES CLOSE FITS

Shaft Tolerances	Hole Tolerances					
	+ 0.0001 — 0.0002	+ 0.0002 — 0.0004	+ 0.0003 — 0.0006	+ 0.0005 — 0.0010	+ 0.0007 — 0.0014	+ 0.0010 — 0.0020
	Allowances					
+ 0.0001 — 0.0001	A + 0.0001 — 0.0004	B^1 + 0.0002 — 0.0006	C^2 + 0.0003 — 0.0008	D^3 + 0.0005 — 0.0012	E^4 + 0.0007 — 0.0016	F^5 + 0.0010 — 0.0022
+ 0.0002 — 0.0002	A_1 + 0.0001 — 0.0006	B + 0.0002 — 0.0008	C^1 + 0.0003 — 0.0010	D^2 + 0.0005 — 0.0014	E^3 + 0 0007 — 0 0018	F + 0.0010 — 0.0024
+ 0.0003 — 0.0003	A_2 + 0.0001 — 0.0008	B_1 + 0.0002 — 0.0010	C + 0.0003 — 0.0012	D^1 + 0.0005 — 0.0016	E^2 + 0.0007 — 0.0020	F^3 + 0.0010 — 0.0026
+ 0.0005 — 0.0005	A_3 + 0.0001 — 0.0012	B_2 + 0.0002 — 0.0014	C_1 + 0.0003 — 0.0016	D + 0.0005 — 0.0020	E + 0.0007 — 0.0024	F^2 + 0.0010 — 0.0030
+ 0.0007 — 0.0007	A_4 + 0.0001 — 0.0016	B_3 + 0.0002 — 0.0018	C_2 + 0.0003 — 0.0020	D_1 + 0.0005 — 0.0024	E + 0.0007 — 0.0028	F^1 + 0.0010 — 0.0034
+ 0.0010 — 0.0010	A_5 + 0.0001 — 0.0022	B_4 + 0.0002 — 0.0024	C_3 + 0.0003 — 0.0026	D_2 + 0.0005 — 0.0030	E_1 + 0.0007 — 0.0034	F + 0.0010 — 0.0040

Machinery

Close fits are all covered by one table in the complete system (see Table 2). Here the maximum shaft is greater than the minimum hole by one-third of the hole tolerance. Thus. interference takes place in certain cases, and this fit is rarely used, except for piston and piston-pin fits, and similar cases, when selective assembly is employed.

Tight fits are covered by one table, which is similar to the table for close fits, except that the maximum shaft is greater than the minimum hole by two-thirds of the hole tolerance. The conditions mentioned relating to the use of close fits apply to tight fits also. In this case, the minimum clearance is still further reduced, although the tolerances remain the same. In practice, the tight fit would be employed only in connection with selective assembly.

Drive fits are covered by a series of eight tables in the complete system. The outstanding feature of this kind of fit is that the minimum allowance still permits a clearance, while the maximum allowance produces interference. This fit finds its most general application in keyway fits, where parts are stationary on their shafts, and where, therefore, either a slight clearance or a fit requiring the key to be driven in, is permissible.

Press fits are covered by a series of thirty-three tables with a minimum allowance varying from + 0.0000 to + 0.050. These fits include all press, heavy drive, and shrinkage fits.

The tables prepared for the complete system, of which only two examples are shown in this article, thus cover a wide range, although this may readily be increased if desired for special work. Certain manufacturers, in the past, have allowed 1/4 inch in clearance between connecting-rod and piston bosses, which accounts for this large allowance in one table in the series of running fits. Again, certain solid tires which are pressed on steel wheels have an allowance of 0.045 to 0.050 inch, which accounts for the range of minimum allowances in the tables for press fits.

The basic tables are not related directly to different classes of machine work, but they are used in compiling such specific tables. The system at present includes, in addition to the basic tables, a table of fits recommended for general use for diameters up to and including 6 inches. A table of fits recommended for gasoline engine parts is also included. This plan of using the basic tables for compiling special tables for different kinds of work is to be continued, the ultimate object being to obtain special tables covering various important classes or types of machinery.

The practical advantages of the one-third and two-thirds division of the tolerances for holes have been explained previously. Now in the case of shafts, the greatest advantage from the viewpoint of shop practice is obtained by an equal division of the tolerance above and below the nominal or mean size, as the case may be. The underlying reason for specifying both plus and minus tolerances for the hole as well as the shaft, is to secure the practical advantage of showing the mean *hole* size as one "bull's-eye dimension," with a plus and minus variation, and the mean *shaft* size as the other "bull's-eye dimension," also with a plus and minus variation. For example, if the dimension for the hole should be $\begin{matrix} + 0.0005 \\ - 0.001 \end{matrix}$ and the shaft dimension, 0.998 ± 0.0005, the mean sizes of 1.000 and 0.998 would represent the bull's-eye dimensions to be aimed at. The same dimensions expressed by the limit method would be as follows:

For the hole, $\dfrac{0.999}{1.0005}$ and for the shaft $\dfrac{0.9985}{0.9975}$.

The writer realizes that the "bull's-eye method" has certain disadvantages, but believes that these are outweighed by the advantages. The disadvantages may arise in the engineering department where fits are dealt with once, and then on paper, whereas the advantages are realized in the production, inspection. and tool departments, where the fits are directly related to iron and steel. The chief advantages in showing the nominal or mean size with its plus and minus tolerance are: (1) The reamer size is always indicated, whether for a standard hole or special hole; (2) gages are marked in the same way, and are more readily classified and identified; and (3) manufacturing is expedited, particularly when gages are not available.

The standardization of hole tolerances controls the number of gages for each nominal size, and reduces it to a minimum. The ultimate aim is to have manufacturers specify the same tolerances for the same nominal sizes in so far as this is consistent with the class or quality of fits required.

This plan will enable gage manufacturers to carry standardized tolerance gages in stock, just as they now carry standard or nominal size gages, which would still be used for reference only, as they properly should be.

Special Holes

Economical manufacturing requires some special holes, chiefly to permit the use of commercial rolled or drawn stock without machining the outer surface. While the amount of work in this class is comparatively small, its importance justifies making the basic tables of allowances and tolerances flexible enough to care for this condition. When the tolerance on such shafts is applied from nominal size to under-size, over-size holes are required for running fits and under-size holes for press fits. For such work, the same basic tables may be used and the same fit identification, to which is merely appended the amount added or subtracted from the nominal size to give the minimum hole diameter.

To illustrate, assume that a running fit is required having a minimum allowance of — 0.0005 and a maximum allowance of — 0.003 inch. The nominal size is 1.000 inch and the diameter of the cold-rolled shafting 0.9995 ± 0.0005. In this case, the hole and shaft sizes that would appear on the drawings would be $1.0015 \begin{smallmatrix}+0.0005\\-0.001\end{smallmatrix}$ (A3D + 0.0005) and 0.9995 ± 0.0005 (A3D + 0.0005), respectively.

Selective Assembly

The selective method of assembling is required for some classes of work, and the flexibility of the uni-bilateral system provides for such special practice. A selective assembly is tolerated only because it would be impracticable to work to the close tolerances required on mating parts and still obtain the fit required. The fit required between a piston-pin and a connecting-rod bushing will be used to show how selective assembly is taken care of. A close fit is desired, and, as previously mentioned, the outstanding feature of such a fit is that the minimum allowance permits clearance, while the maximum allowance produces interference.

The minimum tolerance that is practical for the piston-pin is 0.0002 inch, and the minimum tolerance for the connecting-rod bushing, 0.0003 inch. The table of what are known as Class C allowances (close fits), which is reproduced as Table 2 in this article, shows that the allowances designated as A $\begin{smallmatrix}+0.0001\\-0.0004\end{smallmatrix}$ correspond to a shaft tolerance of $\begin{smallmatrix}+0.0001\\-0.0001\end{smallmatrix}$ and a hole tolerance of $\begin{smallmatrix}+0.0001\\-0.0002\end{smallmatrix}$; hence, the symbol for the fit is CA. In this instance, the dimension for the hole is $1.000 \begin{smallmatrix}+0.0001\\-0.0002\end{smallmatrix} \left(\text{CASA} \begin{smallmatrix}-0.0001\\-0.0002\end{smallmatrix}\right)$, and for the piston-pin $0.9998 \pm 0.0001 \left(\text{CASA} \begin{smallmatrix}-0.0001\\-0.0002\end{smallmatrix}\right)$. Symbol $\left(\text{CASA} \begin{smallmatrix}-0.0001\\-0.0002\end{smallmatrix}\right)$ identifies the class of fit, and the suffix SA $\begin{smallmatrix}-0.0001\\-0.0002\end{smallmatrix}$ of the symbol shows that selective assembly (SA) is required and that a clearance of from 0.0001 to 0.0002 is desired.

Interchangeability of Different Systems

It might be well to mention in closing that interchangeability is equally guaranteed through the use of the uni-bilateral, bilateral, or the unilateral systems. Thus, for the same minimum and maximum allowances in each case, the same quality of fit is obtained, regardless of the relation that the tolerance for the hole or the shaft bears to the nominal size. In other words, any one of the systems referred to gives the same clearance or interference, or any of the various intermediate conditions. Interchangeability, as here referred to, does not mean, of course, that work produced according to one system will interchange with work produced by another, but rather that each system, when considered by itself, is capable of the production of interchangeable parts.

To illustrate, assume that the different systems mentioned are to be applied in obtaining the same quality of fit for a part having a nominal size of 1 inch, with a minimum clearance of — 0.0005 inch and a maximum clearance of — 0.003 inch. Then, according to the unilateral system in which the tolerance is all applied above the nominal size, we have for the hole $1.000 \begin{smallmatrix}+0.0015\\-0.000\end{smallmatrix}$ and for the shaft $0.9995 \begin{smallmatrix}+0.000\\-0.001\end{smallmatrix}$. In applying the unilateral system with all the tolerance below the nominal size, we have for the hole $1.000 \begin{smallmatrix}+0.000\\-0.0015\end{smallmatrix}$ and for the shaft $0.998 \begin{smallmatrix}+0.000\\-0.001\end{smallmatrix}$. According to the bilateral system, the dimension for the hole is $1.000 \begin{smallmatrix}+0.00075\\-0.00075\end{smallmatrix}$ and for the shaft $0.99825 \begin{smallmatrix}+0.0005\\-0.0005\end{smallmatrix}$.

According to the uni-bilateral system, the dimension for the hole is $1.000 \begin{smallmatrix}+0.0005\\-0.001\end{smallmatrix}$ and for the shaft 0.998 ± 0.0005. Although all holes have the same tolerance, a different "Go" and "Not Go" plug gage is required for each system, since each hole bears a different relation to the nominal size. Different "Go" and "Not Go" snap gages are also required for each shaft, but when each shaft is assembled in the hole dimensioned according to the same system, the minimum and maximum clearances are equal in every case. The practical results, however, obtained in producing interchangeable parts cannot be determined merely by a comparison of dimensions as given on drawings, but must be related to mechanical processes and also must take into consideration the human element. When a comparison between the different systems is made on this basis, the writer believes that the uni-bilateral system possesses inherent advantages that justify its universal adoption.

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ADJUSTING THE SALES EFFORT TO THE MARKET

It is wasteful to attempt to sell high-production machinery to shops that do not have mass-production conditions. It is just as wasteful to try to sell the high-production shops machinery that is well fitted to low-production conditions. It is equally wasteful to try to sell either kind of machinery to a shop that has plenty of the proper machinery in its equipment, or to a shop that has not the money to pay for the kind of equipment it ought to have. The marketing problem is to find the kind of shop that *needs* the kind of machinery one has to offer, and at the same time has the money to pay for it.

Some few things may explain the seeming paradox that some machine tool shops are relatively busy, while others are relatively dull. Marketing policy, marketing practice, and executive policy that dictates the character of product made—all these cut large figures in the relative activity of different concerns. All of them finally affect machine tool demand for the individual concern and for the industry as a whole in times when there is no great amount of expansion to swamp the whole industry with orders. Nowadays, orders do come to him who hustles while he waits. We are in a quite normal condition of general business, and there is no boom in sight, so the hustler is often getting business that others are waiting for.—*Ernest F. DuBrul*

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Just about one hundred years ago Stephenson was trying to obtain the consent of the House of Commons of Great Britain to the building of a railroad line. In presenting his petition to Parliament, he had some difficulty in restraining his enthusiasm, and among other statements, he said that on this railroad he would pull trains with an engine of his design that was capable of running at 20 miles an hour. His counsel finally informed him that if he did not moderate his statement about being able to run his engine 20 miles an hour, "and bring it within reasonable speed," he would spoil his chances of obtaining the required permission from Parliament. At the same time, Parliament was urged by outsiders to limit the speed of the newly invented steam engines.

Press Work in Agricultural Machinery Plants

First of a Series of Articles Describing Dies Used in Drawing and Forming Parts for Agricultural Machinery

By C. C. HERMANN

LOW production costs are a prime necessity in building agricultural machinery on account of the economical attitude generally taken by the farmer in purchasing equipment. Hence it is no wonder that this machinery building industry makes extensive use of power presses in seeking the lowest possible costs. Many castings previously used have been replaced by pieces formed from sheet steel, which are not only cheaper but more serviceable. A notable example of this kind is the seat furnished for the driver on binders, reapers, and other machines. When these seats are made of cast iron, they are often broken by accidentally backing the machine against a barn, fence, etc., whereas a steel seat will only be bent in such a happening. This series of articles will describe dies employed in power presses for blanking, forming, and drawing different parts in agricultural machinery shops.

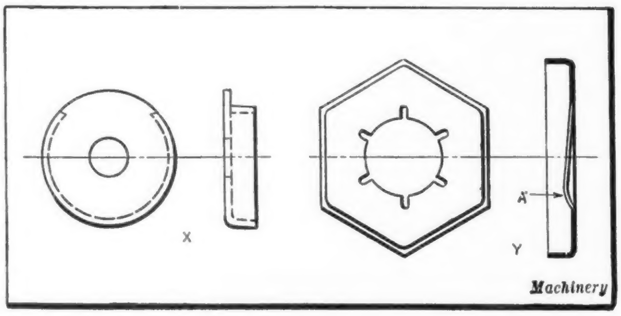


Fig. 1. Two Special Washers produced in Large Quantities in Punch Presses

Designing a Progressive Die for a Simple Washer

A small cup washer commonly used on the hinge rivet of wagon-seat springs is illustrated at *X*, Fig. 1. This washer is about 1 inch in diameter and formed of No. 14 gage annealed sheet steel, with a flange 3/16 inch high extending through 270 degrees of its periphery. A hole is punched in the center of the washer to receive a rivet.

Obviously, any method of producing such a minor part must be founded on a quantity basis if the cost is to be held within reason. It would be far too expensive to blank small disks and feed each one by hand into a forming die. With a magazine feed, two such distinct operations would be practicable, but it is more economical to punch, blank, and form the washers in a single operation. This method requires a progressive combination die. In the preliminary design of a die of this kind, considerable time and study should be given to the steps that will be followed to produce the piece. In designing the die for the washer, a layout such as shown at *X*, Fig. 2, was made. It was decided to first split the raw material into strips of a sufficient width to produce one piece only.

In making such small pieces, it is advisable to keep the blank attached to the strip as long as possible. If this can be done until the final operation is about to be performed, it will avoid the necessity of the operator paying much attention to the location of the pieces of work as they pass through the various stages. In the present example, it was decided to hold the different pieces together by means of a neck *A* until just before the final step.

It was also decided that in starting a new strip through the die, the first step would consist of blanking away the material around one side of the piece from point *B* to point *C* and that with each successive advance of the bar, the blanking punch would cut away the stock from point *B* to point *D* along one edge and from point *C* to point *E* along the other edge. In this way, two pieces are blanked for one-half of their periphery at each stroke of the ram. The second stroke consisted of punching the central hole, and the third stroke, of blanking out neck *A*, and forming the part to the shape illustrated at *X*, Fig. 1.

Construction of the Die

The die, built as outlined, is shown at *Y*, Fig. 2. It will be seen that all four punches are held in one block *F* which is attached to the ram. The blanking punch is shown at *G*, the piercing punch at *H*, the cutting-off punch at *J*, and the forming punch at *K*. It will be noticed that die-block *L* supports the stock in the blanking step, the stock being held down on this block by a stripper plate (not shown). The trimmings, of which there are a good many, fall down a slight incline on both sides of the die-block, so that the operator is relieved of removing them. When trimmings must be removed by an operator, he is often compelled to place his hands in a hazardous position, and, besides, dies are frequently broken through his neglect in removing the trimmings. The successful operation of a die often lies in eliminating the human factor as much as possible.

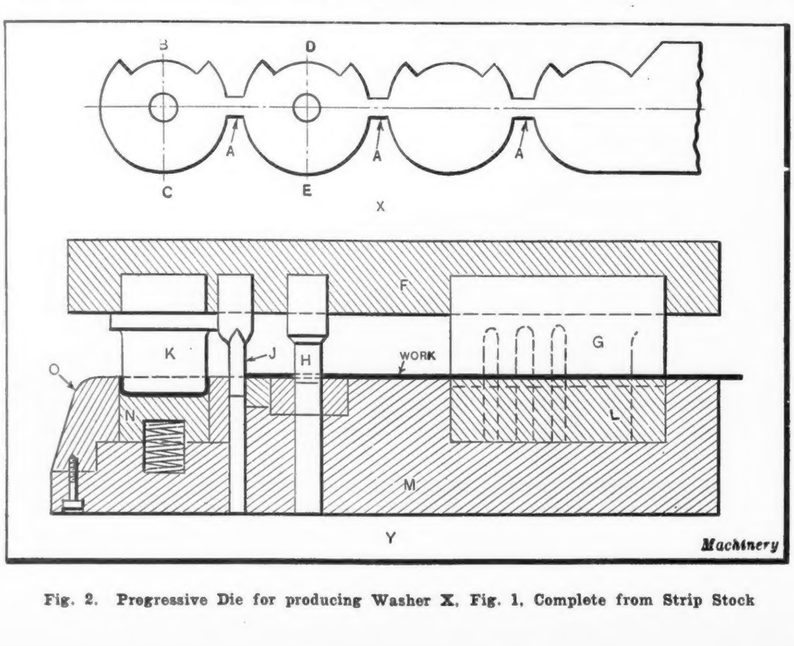


Fig. 2. Progressive Die for producing Washer X, Fig. 1, Complete from Strip Stock

Die-block *M* has a groove in it, in which the stock is fed through the die manually, although an automatic feed could be utilized. The advantage of a manual feed is that if a piece should become stuck in the forming operation, further feeding of the stock can immediately be stopped until the ejector has removed the part. However, the advantage of an automatic feed is that every stroke of the machine is used, and so production is greatly increased.

In this die, a stop is provided at each step to locate the work properly. As punch *H* produces the hole in the center of the blank in the second step, the slug falls through a hole in the die and the die-block. In the next step, punch *J* severs the blank from the bar by blanking out the small neck previously mentioned, which also falls through the die-block. Finally, punch *K* forms the piece to the desired shape by forcing the blank into die *N*, which is free to slide vertically in a recess machined in shoe *O*. A coil spring beneath die *N* backs it up during the forming stroke and raises it at the end of the operation to eject the work. With the next advance of the stock, the work is pushed off die *N*. The downward travel of this die is limited by the depth to which the washer is formed.

Die Employed to Produce a Hexagonal Lock-washer

Another example of a part produced at high rates in a power press is the hexagonal lock-washer shown at *Y*, Fig. 1. This washer is made of No. 16 to 18 gage sheet steel, containing from 0.15 to 0.25 per cent carbon. The central part of the washer around the opening is formed into a spiral to conform to the thread, and the washer is made with a hexagonal flange so that it can be turned readily with a standard wrench. When it is drawn down on a bolt as the nut is tightened, lip *A* grips the bolt thread so firmly as to prevent removal of the nut except with the aid of a wrench. These washers are made in different sizes.

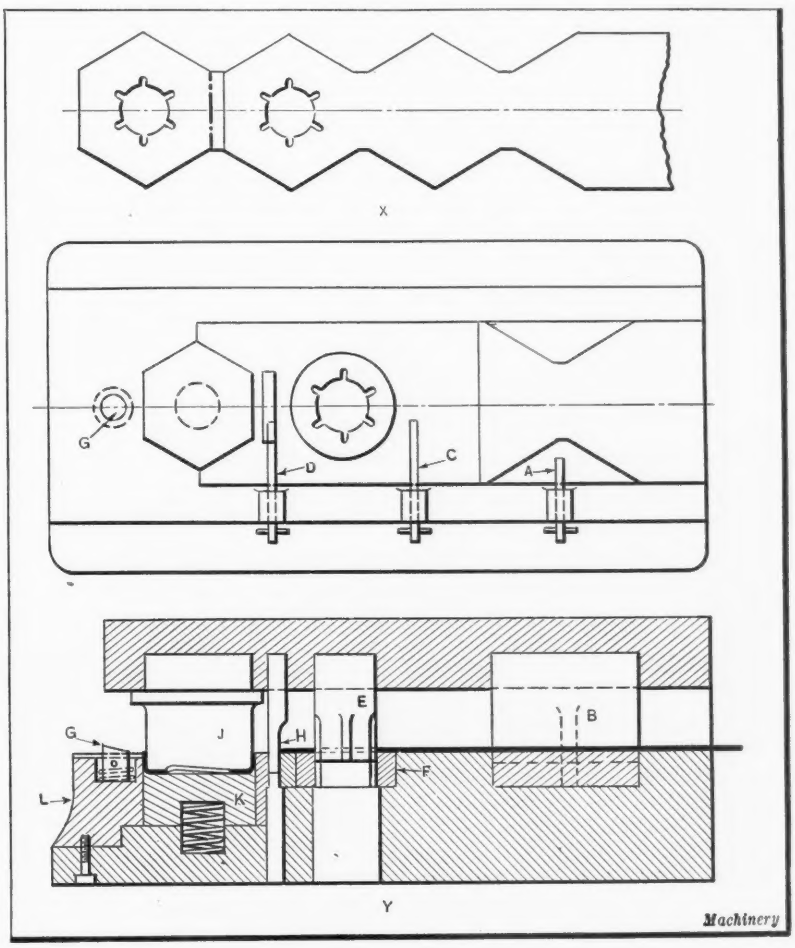


Fig. 3. Punch and Die Equipment employed in making a Hexagonal Lock-washer

The sequence of steps followed in producing the washers may be studied from the lay-out of the stock strip shown at *X*, Fig. 3, which illustrates the different steps up to and including the forming. At *Y* are shown a plan view of the die that is employed, and a sectional view of the punch and die. In starting a new piece of stock through this die, the stock is inserted until it comes in contact with stop *A*. Then, at the descent of the punch ram, punch *B* shears away the stock to form three sides of a hexagon. Stop *A* is next pulled back and the stock advanced to the second stop *C*. At the second stroke of the die, punch *B* trims two more sides of the first washer and two sides of the next one. The stock is now advanced to the third stop *D*, for punching the hole and the small slots around the hole with punch *E*, which enters die *F*. Finally, the stock is advanced to the fourth stop *G*, in which position the washer is severed from the strip by punch *H* and formed to shape by means of punch *J* and die *K*.

Stop *G* is beveled on top, and is surrounded by a spring that tends to hold it in an elevated position. With this construction, the stop can be depressed to allow an ejected piece to be forced over it when the bar of stock is advanced for finishing a successive piece. As soon as the finished part is pushed over the stop, the latter springs up into place to locate the stock for forming the next washer. Stops *A*, *C*, and *D* are withdrawn as a new strip of stock is fed past them, because stop *G* functions to locate the stock for all subsequent washers after the first one of a strip reaches it. Stop *D* must never be in the position shown during a stroke, or punch *H* will strike it. On the side of die-shoe *L* adjacent to this punch, there is a small shear blade which assists in cutting the washer from the strip. In this example, the forming die *K* is also movable in the shoe, and is equipped with a spring which raises the die to hold the work firmly against the punch during the forming stroke and to eject the formed blank at the end of the operation.

Dies Should be Made Heavy Enough

Designers have a tendency to make dies of the type here described too light to withstand the work required of them. The small size of the work often leads to the conclusion that the die may be very light, with the result that it soon becomes worn or broken. This type of die is operated at a high speed in order to keep down production costs, and therefore even a few minutes loss of time in repairing a die means a considerable loss in the number of parts produced. The working elements should be given liberal bearing surfaces, and the different sections as great an area of metal as is consistent with the space available, so as to reduce repairs to the minimum.

The metal from which the die is made has a considerable bearing on its life. For small intricate parts, carbon tool steel is always preferable, and in many cases the parts should be heat-treated to increase their life. The punch-blocks, die-blocks, and die-shoes of the examples here given are made of machine steel, while the punches and dies are made of carbon steel, hardened and ground. In larger dies, iron and steel castings are often suitable for certain parts, but when iron castings are used, the writer prefers a mixture containing about 10 per cent steel scrap and enough carbon to permit easy machining.

Aligning Die Parts by the Use of Guide Posts

It is important that dies of this type register accurately, and to assure this, guide posts are often used. Guide posts also facilitate lining up the parts in setting up the punch and die for an operation. Without them, the average set-up man rarely gets a die so lined up that the clearance is equal around the punch, and when there is unequal clearance, poor work, and not infrequently, broken punches and chipped dies are the result. When a die is equipped with guide posts, the proper clearance is insured around the working elements until enough wear has taken place on the guide posts or in the guide bushings to permit the die parts to shift. An additional advantage of guide posts is that they

make a die set more or less self-contained so that the different parts are held together when off the press. Thus there is less trouble from chipped, jammed and misplaced parts.

When dies are equipped with guide posts, the base block should not be bolted to the press in the usual manner, but should be held down instead by clamps. If bolts are used, some careless operator will bolt the block to the table without first running the punches up and down in the dies a few times to test the setting. Then the result will probably be sprung guide posts or a broken die or machine, and in any event, wear will be considerably increased if the die parts bind in operation. When the base block is simply clamped in place, the punch-block should be first bolted to the ram and then the base clamps tightened. Should the die parts then bind in a preliminary test, the base block will shift sufficiently to remedy the condition.

* * *

EXPOSITION OF FORGING MACHINERY

During recent years important developments have been made in forging methods and in the design of forging machinery. Through these developments higher production rates and better forgings have been made possible. Improvements have been made not only in the machines themselves but also in the dies, thereby adapting the process to a wider range of work. Today it is possible to forge many parts that could not have been forged in the past.

With a view to providing an opportunity for officials from railroad and industrial plants to see the latest types of forging machines under actual operating conditions, the National Machinery Co., of Tiffin, Ohio, has arranged for an exposition of recent methods and designs of forging machines and nut and bolt machinery, to be held at its plant in Tiffin during the four days Friday, August 21, and Monday, Tuesday, and Wednesday, August 24, 25, and 26. The Railway Master Blacksmiths' Association will be in convention in Cleveland at about this time, and has accepted the National Machinery Co.'s invitation to visit Tiffin on August 21. This day, therefore, has been set aside as Master Blacksmiths' day. The convention delegates will be taken to Tiffin on a special train. The latter three days are set aside for railroad officials and for men from the general industrial field.

The exhibit will be on a broad scale; sixty-two machines will be shown working under actual manufacturing conditions, and eleven machines will be exhibited partially or wholly disassembled in order to show their design and construction. An idea of the range of the equipment to be shown may be gathered from the fact that the smallest machine exhibited will be a 1/8-inch automatic nut tapping machine weighing 125 pounds, while the largest will be a 5-inch heavy-pattern forging machine weighing 130,000 pounds. Such auxiliary equipment as furnaces, blowers, and electric heaters will also be exhibited, and a complete bolt and nut plant will be operated on a production basis.

Among the machines exhibited will be a new line of high-duty forging machines which have not previously been announced to the trade. Dies have been made up for each machine, and complete information will be available concerning the proper steels and heat-treatment for use in the making of forging dies. Visitors to the exposition will have an opportunity to see a wide range of mechanical forging equipment and judge of its possible application in the manufacture of their own products. The company's plant will also be in regular operation, so that the visitors may have an opportunity to see the methods employed in the building of forging machinery and equipment.

* * *

The production of natural abrasives in 1924 amounted to about 190,000 tons, valued at nearly $4,000,000, as reported by the Department of the Interior. In addition, more than 60,000 tons of artificial abrasives, valued at over $6,200,000, were manufactured.

CHART GIVING WEIGHT OF MATERIAL REQUIRED FOR STAMPINGS

By RONALD L. WAKELEE

The accompanying chart was designed to assist the tool engineering department in the work of estimating the weight of the raw material required to make 1000 sheet-metal stampings the stock size for one piece having been predetermined by the size of the blank. The information thus obtained is passed on to the purchasing department. The scope of the chart is unlimited; for instance, in the example given, had the length L been 57.5 instead of 5.75, the weight would be ten times as much, or 2440 pounds. The results obtained in this manner should closely approximate ordinary slide-rule accuracy.

In using the chart, place a straightedge, preferably celluloid, at the points on the L and B scales corresponding to the figures given, and revolve the straightedge about a pencil point held at the intersection of the straightedge and the line XX until it lines up with the given figure on the T scale, then read the weight at the point of intersection on the W scale. The constant 1.08 given in the lower right-hand corner of the chart is for brass composed of 70 per cent copper and 30 per cent zinc. The constants for brass of different compositions or of other materials can be obtained by dividing the specific gravity of the material by the specific gravity of steel. On page 1416 of the sixth revised edition of MACHINERY'S HANDBOOK is a table giving the specific gravity of various materials, including brass having different proportions of copper and zinc.

* * *

CHROMIUM PLATING

An electrolytic method was developed some time ago by Dr. Colin G. Fink, head of the division of electro-chemistry, Columbia University, by means of which ancient bronzes, corroded beyond recognition, can be restored to their original form. Dr. Fink, with the help of assistants and the research engineers of the Chemical Treatment Co., has now developed a commercial process for chromium plating. The use of small percentages of chromium to produce stainless or rustless steel alloys and extremely hard chromium steels is well known, and the advantages of a chromium coating on other metals as a protection against corrosion, which would also greatly increase the surface wearing qualities, has long been apparent. In appearance, a chromium plated surface may be a dull gray or it may have a silver luster. It can be polished so that it will be more brilliant than nickel and have practically the same reflecting power as a high-grade mirror. As the surface will not tarnish or corrode, no additional polish is ever required, and it will outlast similar surfaces. Chromium-plated articles will be produced by Dr. Fink's method under the trade name "Crodon." It is expected that the extended use of chromium-plated articles will afford manufacturers in many fields an opportunity to discard high-priced alloys and to make many products from more easily worked metals.

* * *

COURSE IN INDUSTRIAL ENGINEERING

Lehigh University has announced that beginning next September a four-year course in industrial engineering will be inaugurated. Recognizing that every modern enterprise depends on sound financing, adequate accounting, and intelligent forecasting of economic developments, the faculty at Lehigh will undertake to produce engineers as thoroughly grounded in these fundamentals of business as in mathematics, physics, and scientific subjects. The curriculum is primarily of an engineering character, and will equip the student with sufficient technical knowledge to make him at home in a highly technical environment. In addition, however, it will include courses in economics and business that will be of service to those graduates who enter the less technical departments of any of the various industries that are essentially technical in character.

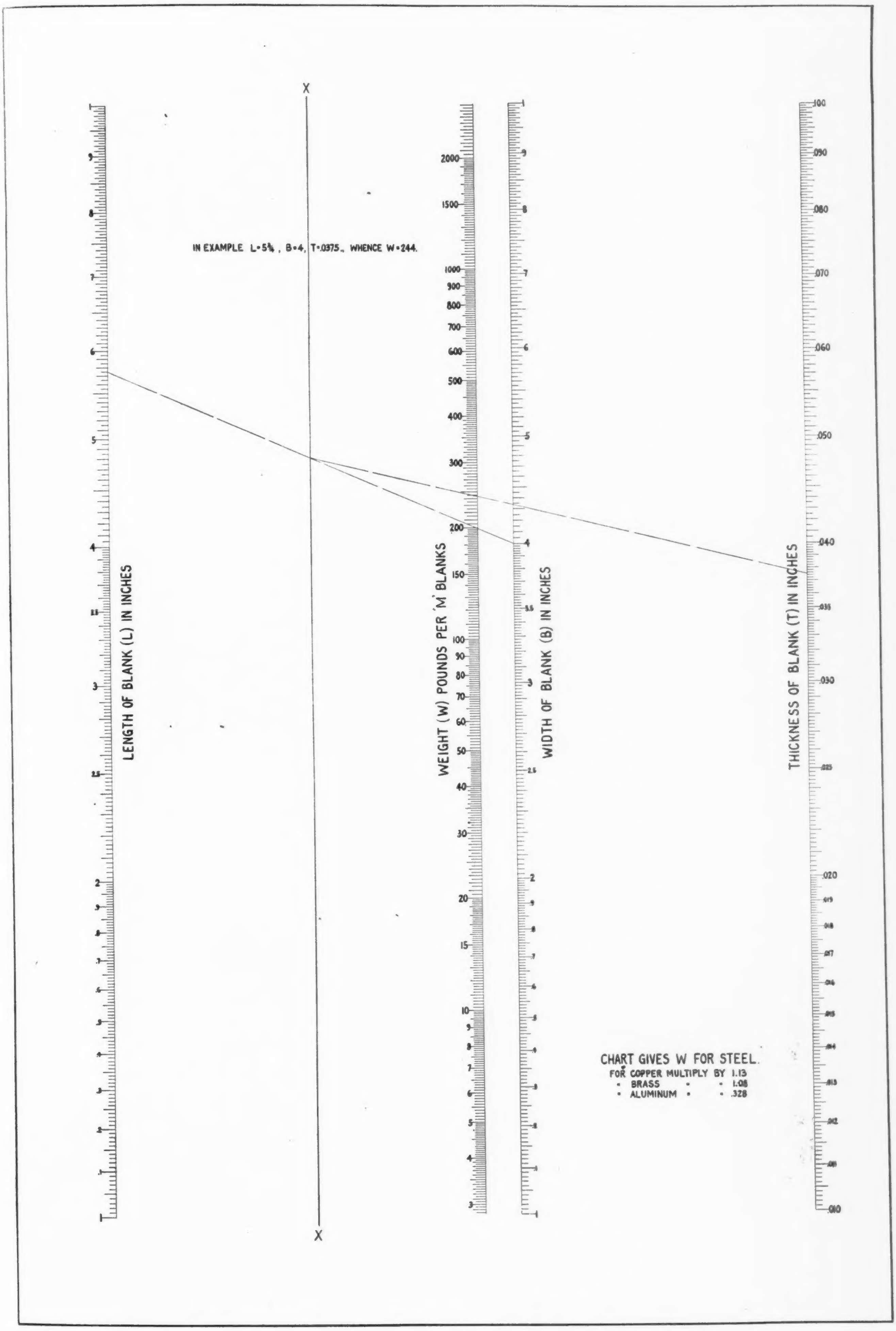


Chart giving Weight of Raw Material required for 1000 Sheet-metal Stampings

MAKING ROLL THREADER DIES

By ARTHUR L. GREENE

In bolt and nut manufacturing plants, as in other large metal-working shops, the tool-room plays a major role in determining the amount of production and the quality of the output. Automatic and semi-automatic machines must generally be kept equipped with accurately made tools, dies, or fixtures, which, of course, is the job of the tool-room. One of the most interesting examples of toolmaking in a bolt and nut manufacturing plant is the machining of the dies employed in rolling the thread on bolts. The rolling method is applicable to any size of bolt, whether it be a small set-screw or a large, heavy track or frog bolt used in railroad construction. In the following will be described the methods followed in making a pair of roll threader dies at the plant of the Buffalo Bolt Co., North Tonawanda, N. Y.

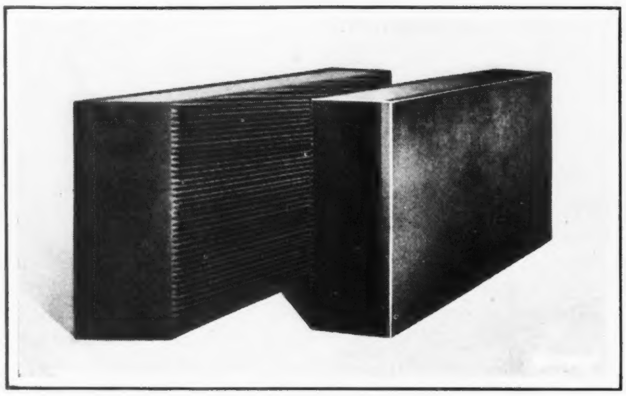


Fig. 1. Pair of Dies used in rolling Threads on Bolts

Fig. 1 shows a pair of finished dies; it will be noted that one die, known as the "live" die, is slightly longer than the other, or "dead" die. The inner surface of each die is threaded and the threads at both ends of the blocks are slightly relieved. In making one of these dies, a bar of suitable steel is cut off to length, with a sufficient allowance for machining. This piece of steel is finished accurately to size all over on a planer, and then taken to a milling machine for the important operation of cutting the threads.

The Milling Operation

Before milling the threads, it is essential that the piece of steel be placed level on the table of the machine, and at such a sidewise angle relative to the cutters that the threads will be produced on the die at the proper lead. To obtain and maintain this angular position of the work, use is made of a wedge-shaped piece of hardened steel. This wedge is placed against the left-hand side of the die, as shown at *A*, Fig. 2, and the die-block clamped against it by means of several blocks and adjusting screws, as illustrated. Wedge-shaped blocks are kept in stock in many sizes and for all required lead angles. In the milling operation, successive cuts are taken across the face of the die until the proper depth of thread has been reached.

Relieving the Threads

After the milling operation, the threads at both ends of the dies must be relieved. The successful performance of this operation is essential to the proper working of the dies in the threading machine, as the bevel, or relief, serves two purposes: First, it permits convenient insertion of the bolts between the threader dies; and second, it gradually reduces the pressure of the dies on the bolts toward the end of the stroke, and thereby prevents nicking of the bolt threads, which would occur if the pressure was suddenly released. The ends of the "live" die can be beveled on the planer or by hand with a file, as these threads are relieved only on top, but the ends of the "dead" die must be beveled by the hand process, because the sides of the threads on this die, as well as the top, are relieved.

In relieving the threads of a "dead" die, the die-block is clamped in a vise, as shown in Fig. 3. Then a line is scribed across each end of the die at right angles to the threads and at a minimum distance of about 3/8 inch from the end. This line indicates the extent to which the die will be relieved. The top of the thread is then relieved entirely to the depth of the threads. After the top relief has been filed, the depth of each thread is extended at the end by means of a triangular-shaped file. Next, the sides of the threads are filed until they meet the unfiled portions in the form of an arc. This operation is performed on both ends of the die. Threads of the "live" die are merely beveled slightly on top. After the relieving operation, the dies are hardened and tempered. Large roll threader dies are generally reworked several times as the threads become worn. When the threads are worn to the extent that they no longer do satisfactory work, the dies are taken from the machine, annealed, and sufficient surface material planed from them to permit cutting entirely new threads. Dies may be reworked until too thin for further reworking.

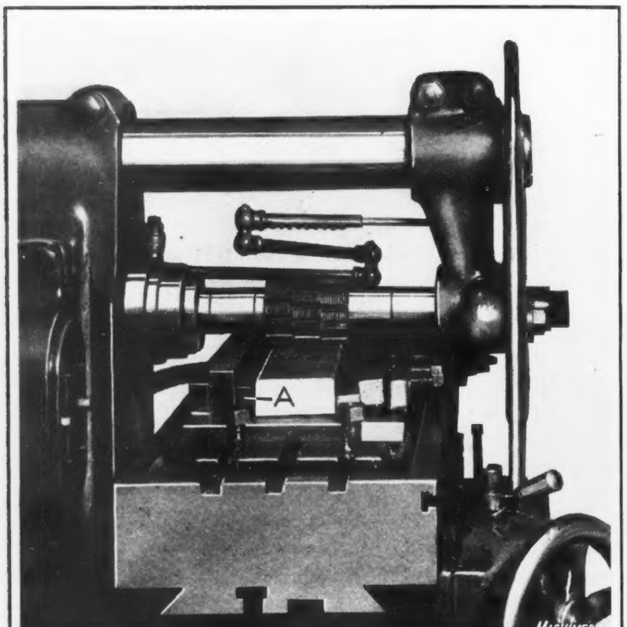


Fig. 2. Milling the Threads at the Desired Lead Angle

Fig. 3. Relieving the Ends of the Threads by Hand-filing

Notes and Comment on Engineering Topics

The rapid growth of bus transportation in the United States is indicated by the fact that at the present time there are approximately 60,000 buses in operation. The number of passengers carried by these buses in 1924 was approximately 3,000,000,000.

Four unusually large electric storage batteries have recently been installed by the Automatic Telephone Mfg. Co., Ltd., Liverpool, England, for the automatic telephone exchanges in London. Each cell is 5 feet 8 inches in length, 5 feet in height, and 1 foot 8 inches in width, being provided with thirty-five positive plates, and having a total weight, including the electrolyte, of over 2 tons.

After severe service tests, a four-mile coal conveyor system of the belt type, operated at East Roscoe, Pa., is considered a practical success. This conveyor, consisting of twenty separate belts, carries coal to barges on the Monongahela River for a distance of more than four miles. Power is supplied by twenty electric motors ranging in horsepower from 50 to 175. The conveyor is able to handle over 1200 tons of coal per hour.

The British Power Alcohol Association is endeavoring to develop the use of alcohol for power purposes. It is pointed out that power alcohol can be made in small distilleries from sugar beets; by this method, Great Britain could eventually supply about 40 per cent of her present motor fuel requirements. Power alcohol can be mixed with gasoline, it is stated, in any quantity up to equal volumes, and will provide an efficient motor fuel.

A new idea for providing parking space for automobiles in large cities has been put forward by the Automobile Association of Great Britain. This association suggests that the difficulty of parking space in large cities should be met by providing underground parking places, particularly under open public squares, parks, or possibly under public buildings. Sooner or later some such means as this must be adopted if the automobile continues to be used for individual transportation in large cities.

At the recent annual meeting of the Society of German Engineers at Augsburg, an interesting exhibit was arranged by the city, containing a collection of models and drawings of engineering structures and works from its early history. According to tradition, water-wheel driven factories were in operation in Augsburg as early as the eleventh century, and there is documentary evidence of the operation of six mills in 1276. In 1761, there were over sixty factories provided with water power for diamond and glass grinding, the manufacture of powder, oil, flour, tobacco, and spices, as well as textile and saw mills. A great many interesting models of water power machinery, some dating from the fifteenth century, illustrated the technical practice of that day.

A new method of surveying has been used successfully by the British authorities in India. With this method, the entire survey is carried out by photographing the territory to be surveyed from the air; detail maps are then prepared from the results of this air photography. In this way, a territory of 1350 square miles has been surveyed at a cost of less than 60 per cent of the cost of ground surveying. It has also been possible to carry out the survey much more rapidly than if the old methods had been used, and the photographs give considerable local detail which could not have been obtained and recorded by any other means. It is likely that this method of surveying will form an important part in the mapping of sparsely settled territories in the future.

An interesting safety device has recently been designed and put into operation by a British concern with a view to warning pedestrians and automobilists of the approach of a car emerging from a garage or warehouse doorway. The device consists of a miniature truck which runs on rails extending from the top of the doorway above the pavement outside of the garage, and which automatically precedes an automobile emerging from the doorway. The miniature truck is illuminated at night and its movement is accompanied by three blasts from a horn. The operation of the device is entirely automatic; it is actuated by the emerging car passing over a hinged lid or cover fitted across the roadway on the inside of the garage a certain distance from the door. When the car has passed out of the doorway, the warning-signal truck automatically returns.

The extent to which commercial aviation has been carried in Europe will be appreciated when it is mentioned that a total of 13,550 miles of regular air routes are in operation, of which 5400 miles are covered by one company operating a great number of regular services in Central Europe. As examples of the service provided, it may be mentioned that the distance from Christiania in Norway to Dresden in Germany is covered in 8 1/2 hours, as compared with about 28 hours by rail and water. From Malmo in Sweden to London, via Hamburg and Amsterdam, the air service requires 8 1/4 hours. This was formerly a 36-hour journey. The distance from Berlin to Stockholm is covered in 7 1/2 hours, as compared with 23 hours formerly. In 1924 the Junkers' Airplanes, a German corporation operating routes extending over 1300 miles, carried more than 40,000 passengers and 315,000 pounds of mail.

Sound waves set in motion by the voice of the speaker were thrown on a screen during the delivery of a paper on the measurement of noise in an automobile by H. Clyde Snook, of the Bell Telephone Laboratories, at the recent summer meeting of the Society of Automotive Engineers. The moving light waves were projected by means of an oscillograph throwing a beam of light from a tiny mirror oscillated by electrical impulses set up in an electrical receiving, transforming, and amplifying apparatus by vibrations in the air caused by the speaker's voice.

Lantern slides showing the construction of the human outer and inner ear and the nerve filaments that receive the low and high notes within the range of audibility were also exhibited in one of the most entertaining and absorbing addresses and demonstrations ever given before the members of the society. The purpose of the address on sound and its measurement was to throw additional light on the studies of noise in automobiles with a view to eliminating disagreeable noises.

PACK-HARDENING

Pack-hardening, as the term is generally understood, consists of treating steel, usually high-carbon tool steel, with some carbonaceous material until it will harden in oil. Pack-hardening may be considered as a special kind of casehardening applied to steel containing a higher percentage of carbon than the steels generally treated by the process commonly known as casehardening.

CREOSOTING PROCESSES

Different methods are used for applying creosotes or other preservatives to wood poles. In the closed-tank method, the poles are placed in a large tank and steamed for from five to eight hours; a partial vacuum is then applied, after which the creosote is run in at a temperature of from 140 to 175 degrees F. under sufficient pressure to obtain the amount of absorption desired. In the open-tank creosoting process, usually applied to the butts of poles only, the poles are placed in an inclined or vertical position with the butts immersed in the creosote, which is kept at a temperature of about 220 degrees F., for about six hours. The bath is then allowed to cool, and after it has fallen to 110 degrees F., the poles may be removed; or the poles may be changed to a cold bath (110 to 150 degrees F.) and allowed to remain for several hours. During the period of the warm bath, the air and moisture in the cells of the wood are driven out, and during the period of cooling off, the creosote enters the cells and remains there. By the open-tank method it is not possible to impregnate the wood to the same depth as with the closed-tank or pressure method. The treatment is, however, worth while, and the United States Forest Service estimates the useful life to be approximately twenty years for chestnut and western cedar, twenty-two years for northern white cedar, and twenty years for pine in the dry climate of western United States. In this connection, it should be mentioned that in poles with treated butts, it is the upper part of the poles that will decay first and govern the life of the pole. In the so-called "brush treatment," the preservative is applied with a brush. This practice is sometimes modified by pouring or spraying the preservative on the poles.

CADMIUM SOLDER

Cadmium solders may be used for soldering tin plate, terneplate, brass, and copper, according to an investigation made by the Bureau of Standards. Four different compositions of cadmium solders have been tried: (1) Lead, 90 per cent; cadmium, 10 per cent; (2) lead, 80 per cent; cadmium, 10 per cent; tin, 10 per cent; (3) lead, 85 per cent; cadmium, 10 per cent; tin, 5 per cent; (4) lead, 75 per cent; cadmium, 10 per cent; tin, 15 per cent. The manufacture and use of the alloy first mentioned is rather difficult, because it oxidizes easily in the molten condition. The best composition is said to be that containing 80 per cent of lead and 10 per cent each of cadmium and tin.

OSTWALD CALORIE

The calorie or metric heat unit generally used in engineering is the kilogram-calorie, also known as kilocalorie or large calorie, which is equivalent to the heat required for raising the temperature of one kilogram of water one degree C. In electro-chemistry, a unit known as the *Ostwald calorie* is frequently used. This is equivalent to the amount of heat required for raising the temperature of one gram of water from 0 to 100 degrees C. One kilogram-calorie equals 10 Ostwald calories.

OXY-ACETYLENE FLAME

The combustion of acetylene in oxygen produces an extremely high heat, and the oxy-acetylene flame is, therefore, used for the process of fusing and uniting metals by the application of intense heat in autogenous welding. One or both of the gases used may be under pressure, the gases being mixed in the nozzle of the torch prior to combustion. The use of the oxy-acetylene flame for welding was first experimented with by E. Fouche, of Paris, France, in 1901. The principle of the oxy-acetylene torch or burner is essentially the same as that of the oxy-hydrogen blowpipe, which had been used for many years previous for generating intense heat. The temperature produced by the oxy-hydrogen flame, however, is estimated to be only 4000 degrees F., while that of the oxy-acetylene flame is estimated at about 6300 degrees F. Not only is the flame of acetylene much hotter than that of hydrogen, but the number of heat units per cubic foot of gas is about five times as great, the ratio being as 330 to 1600. Hence, both the intensity and amount of heat of the oxy-acetylene flame, as compared with other heat-producing mediums, are superior. The oxy-acetylene flame is also used for cutting metals. When iron and steel are heated to a high temperature, they have a great affinity for oxygen and readily combine with it to form different oxides, which cause the metal to be disintegrated and burned with great rapidity.

BABBITT METAL

Babbitt is the name given to a great variety of white metal alloys used as linings for bearings. The name is derived from that of the inventor, Isaac Babbitt, who, in 1839, obtained a patent for a special type of bearing enclosing a soft metal alloy. The exact composition of the original babbitt metal is not known, but the ingredients were copper, tin, and antimony, in approximately the following proportions: 89.3 per cent tin; 3.6 per cent copper; and 7.1 per cent antimony. This metal possesses great anti-frictional qualities, but the high percentage of tin makes it expensive and has led to the substitution of other metals which are marketed under the name of "babbitt metal." These cheaper grades, when properly made, are superior to the original babbitt metal for some purposes. The composition of babbitt metal should be varied according to the pressure to which it will be subjected and the speed of the rotating member; the size of the bearing and thickness of the babbitt metal lining should also be considered. While it is not necessary to use a different composition for each slight variation, a different grade is preferable when the conditions are radically different.

WATER-WHEEL AND TURBINE GOVERNORS

Two general types of governors are employed for the regulation of water-wheels and turbines. In the first of these, the transmission of energy from the governor to the speed gate or nozzle, as the case may be, is brought about mechanically, by means of levers or gearing. The governor may be of the fly-ball type, so arranged that a movement of the spindle acts on a reversing clutch, which, in turn, engages with a train of gearing attached to the regulating shaft, thus opening or closing the gate, as may be required. Motive power for rotating the balls and operating the gearing is obtained from the main shaft by means of a belt and pulleys. The other form of governor is known as the "oil-pressure" type, in which oil, under air pressure, acting on a piston, furnishes the motive power for operating the gate or nozzle mechanism.

BOOSTER ON LOCOMOTIVE

The booster which is applied to some of the modern locomotives is a supplementary engine with small cylinders applicable to the trailing wheels of any locomotive that has trailers. It is used in starting and at slow speeds, and cuts out automatically when the speed of the locomotive reaches about 15 miles an hour. Its operation is similar to the low gear of an automobile. It may be cut in at low speeds in order to get over a heavy grade which might be too steep for the main engine alone.

NAIL-HOLDING POWER OF WOOD

Tests made to determine the nail-holding power of various woods, with various sizes of nails from 8d to 60d, indicate that white pine has a very low holding power as compared with yellow pine, white oak, chestnut, and laurel. As a general average, if the holding power of wire nails in white oak is assumed to be 100 per cent, then the holding power of wire nails in white pine is 18 per cent; in yellow pine, 34 per cent; and in laurel, 69 per cent. The holding power of cut nails, compared with the holding power of wire nails in white oak as 100 per cent, is as follows: Cut nails, in white pine, 43 per cent; in yellow pine, 71 per cent; in white oak, 130 per cent; in chestnut, 73 per cent; and in laurel, 128 per cent. Experiments relating to the holding power of 6d nails in different kinds of woods, compared with the holding power in white oak as 100 per cent, gave the following results: White pine, 31 per cent; yellow pine, 54 per cent; bass wood, 40 per cent; hemlock, 61 per cent. In some kinds of wood, the holding power of cut nails is twice that of wire nails. This is especially the case in the softer woods. In the harder woods, the superiority of the cut nail over the wire nail varies from 30 to 50 per cent. In white pine, cut nails driven with the taper across the grain show a superiority over wire nails of as high as 135 per cent.

ELECTRIC FIXTURE THREAD

The special straight electric fixture thread consists of a straight thread of the same pitches as the American standard pipe thread, but having the U. S. standard form; it is used for caps, etc. The male thread is smaller, and the female thread larger than those of the special straight-fixture pipe threads. The male thread assembles with a standard taper female thread, while the female thread assembles with a standard taper male thread. This thread is used when it is desired to have the joint "make up" on a shoulder. The gages used are straight-threaded limit gages.

LEAD OF A SLIDE-VALVE

The lead of a slide-valve is the amount of port opening when the piston is at the end of its stroke and the engine is on the dead center. The lead ordinarily varies on engines of different size, from 0 to about 3/16 inch, 1/16 inch being a fair average for ordinary slide-valves. This initial port opening at the beginning of the stroke is intended to fill the clearance space in the cylinder and give the piston full steam pressure at this point. The amount of lead is sometimes determined by experiment after the engine is erected. When there is little or no lead, the tendency is for the piston to move under reduced pressure through part of its stroke, especially if the ports are small and the clearance space large. In some cases, however, a small amount of lead gives good results, especially when the compression is sufficient to produce a pressure at the beginning of the stroke nearly equal to the boiler pressure. Naturally a quick-acting valve requires less lead than one that opens more slowly.

MUSIC WIRE

Music or piano wire is made from a high grade of steel in diameters of from 0.004 to 0.180 inch. There are many different gages to which this class of wire is made, but the piano wire gage designated as the "American Steel & Wire Co.'s Music Wire Gage" is adopted as standard for piano wire in the United States, upon the recommendation of the U. S. Bureau of Standards. The smaller diameters of music wire have an ultimate tensile strength of from 300,000 to 340,000 pounds per square inch. The composition of this wire is as follows: Carbon, 0.57 per cent; silicon, 0.09 per cent; sulphur, 0.011 per cent; phosphorus, 0.018 per cent; manganese, 0.425 per cent.

PLASTER-OF-PARIS

Plaster-of-paris is a calcined gypsum from which the water has been driven off by heat. Plaster-of-paris, when diluted with water into a thin paste, sets rapidly, and at the instant of setting, it expands or increases in bulk. This material is, therefore, used for making casts of statuary, etc., as it fills the forms perfectly. It is also used as a pattern material. Plaster-of-paris sets in from three to six minutes, but if, for any reason, it is desired to keep the mass plastic for a longer period, this may be done by adding a drop of glue to a five-gallon mixture. This will keep the plaster-of-paris soft for a couple of hours. Citric acid will also delay the setting of plaster-of-paris for several hours. One ounce of citric acid will delay the setting of one hundred pounds of plaster-of-paris for two or three hours. The acid is dissolved in water before being mixed with the plaster. Plaster-of-paris, when mixed with cold water, has an expansion of about 1/16 inch to the foot when hardening. If this expansion is undesirable, it may be mixed with warm water or lime water, in which case the expansion is negligible. When mixing plaster-of-paris, water should not be poured on the plaster, but the plaster should be sprinkled into the required amount of water until it sets as a powder upon the surface of the water. Then it should be stirred quickly by hand until the mass attains the consistency of heavy cream, when it is ready for use.

PAINT FOR HIGH TEMPERATURES

Paint that will withstand high temperatures, even up to a red heat, has the following composition: Lampblack, 3 pounds; graphite, 3 pounds; black oxide of manganese, 1 pound; Japan gold size, 1 pint; turpentine, 1.5 pint; and boiled linseed oil, 1 pint. Powder the graphite and mix all the ingredients to a uniform consistency; give two coats. The following mixture is also recommended: Black oxide of manganese, 2 pounds; graphite, 3 pounds; and terra alba, 9 pounds. Mix and pass through a fine sieve, then mix to the required consistency with the following compound: Sodium silicate, 10 parts; glucose, 1 part; and water, 4 parts.

ELECTROMOTIVE FORCE

The work done in moving a positive charge of electric current around any closed path or circuit in an electric field is defined as the "electromotive force" acting around this path. The electromotive force is generally abbreviated E.M.F. In a strictly correct mechanical sense, electromotive force is not a force, but should rather be defined as work per unit charge. The unit for measuring electromotive force is called a volt, one volt being the electromotive force required to produce one ampere of current against the resistance of one ohm.

What Our Readers Think

on Subjects of General Interest in the Mechanical Field

DRAFTING-BOARD VERSUS WORK-BENCH DESIGNING

There seems to be a tendency in some plants to eliminate, whenever possible, the process of planning and designing jigs and fixtures on paper and to have the toolmaker or machinist make up the equipment directly in metal according to his own ideas or the ideas of someone who gives him verbal instructions. Any doubt as to the value of a carefully worked out design, as compared with such haphazard methods, is eliminated, when one reflects on the fact that a designer encounters a large number of problems and decides on the design of many fixtures or mechanisms, while the toolmaker is engaged in building a single fixture.

The greater variety of jig and fixture problems handled by the designer naturally makes him better equipped to solve designing problems. Actually, the fixture or jig must be designed by someone, and it is obvious that the designer can do this work more efficiently than the toolmaker, who must either serve in the capacity of designer or work out the design in metal step by step, in which case changes cannot be made or errors eliminated without considerable expense. Except in a very few instances, the designing of a fixture or jig, unless it is of the simplest type, should be done on the drawing-board and not at the shop work-bench.

Frank H. Mayoh

* * *

UNNECESSARY ACCURACY IS WASTEFUL

From time to time Machinery has called attention to the cost of making tools or machine parts with a greater degree of accuracy than is necessary for the purpose for which they are intended. It is just as wasteful of money, time, and energy to expend labor on refinements that serve no purpose as it is to spoil good material by careless and inaccurate work when the purpose in view requires extreme care and precision. We need sound judgment to determine the degree of accuracy required for different purposes.

Unnecessary accuracy may also cause waste of time in engineering offices and drafting-rooms. Accuracy is the first requirement in engineering, but it may be misplaced. Sometimes engineers and designers make calculations with extreme accuracy, when absolutely accurate results cannot be obtained, or, if obtainable, would be unnecessary for any practical requirements. Such accuracy may be a sign of careful work, but it is an indication of poor judgment.

An example may be used to illustrate the point in question. Assume that a girder 24 feet between supports is subjected at the center to a maximum load of 20,000 pounds; assume further that the safe stress in the girder must not exceed 16,000 pounds per square inch. The entire calculations are based on assumptions given in round numbers; therefore, it is not necessary to obtain the calculated stress (assuming the section modulus for the beam proposed to be 88.4) as 16,289.59 pounds. Time is wasted in carrying out the calculations to this extent. For all practical purposes, it is sufficiently accurate to say that the maximum stress is 16,300 pounds per square inch, a value slightly too high.

Approximations like these, of course, are permissible only when the factors entering into the problem are based upon assumptions which themselves are likely to vary to a considerable degree. When we speak of the ultimate strength of a certain grade of steel as 60,000 pounds per square inch, it may actually be 59.700 pounds or 60,400 pounds, if subjected to a test in a testing machine. We have to assume these values in order to make practical calculations, and we base them on known averages that have proved safe in the past.

There are other engineering calculations that require the most extreme accuracy, but in that case all the factors involved in the problem at the outset must be definitely and accurately known. In such cases no assumptions or approximations are permissible. What the engineer and designer needs more than anything else is ability to decide when and when not extreme accuracy is required—ability to distinguish between essentials and non-essentials. When he has that faculty, he will avoid a great deal of wasted time.

V. E.

* * *

THE RAILROAD SHOP—THE IMPORTANT LINK

Recently a man well informed on the financial operations of railroad management said to me that in machinery circles the importance of machine shop equipment in the railroad shops was over-emphasized. To the railroad managing official, the railroad shop was only one link in a big chain, representing, perhaps, not more than 1 per cent of the total investment in the entire railroad property. Its relative importance did not loom up as big in the operation of the system as the perfect condition of the permanent way, the signaling system, ample yard space and terminal facilities, an efficient and safe system of train dispatching, etc.

This sounds very plausible at first, and one is inclined to think that possibly the importance of shop equipment has been over-emphasized; but as one studies the subject in detail, does one not have to admit that the shop equipment link in the chain of perfect railroad operation is the vital link, without which the whole chain is useless? Of what value is a perfect permanent way, a faultless signaling system, ample yards and fine terminals, an efficient train dispatching system with excellent means of communication, if the rolling stock of the railroad, for the movement of which all these other things are provided, is not kept in perfect condition through adequate shop equipment? To say that the railroad shops are but a small and unimportant link in the whole chain is about equivalent to building a great and imposing office building, and then saying that it is of no particular importance as to whether means are provided for obtaining suitable tenants for the building. The whole object of building the structure is to provide suitable quarters for tenants, and without tenants the structure is useless. In the same way, the only reason for a permanent way, a signaling system, yards, terminals, and a dispatching system is to provide safe and ample facilities for the moving of rolling stock to carry freight and passengers. If you do not keep this rolling stock in good condition through adequate shop equipment, the excellence of all the other facilities is nullified.

I would suggest that the importance of the shop link in the railroad chain be measured not by the comparatively small investment required for shop equipment—which is all the more reason for keeping it in the best possible condition—but by the importance that rolling stock kept in first-class condition plays in the operation of a railroad system.

A. O.

* * *

A peace record for copper production was established in 1924, when approximately 1.675,000,000 pounds of domestic new copper was refined in the United States.

Dies for Sheet-metal Cover

By FRANK H. MAYOH

IN many plants, it is the practice, when designing press tools, to make a drawing that shows the part as it will appear after each successive operation, and then make outlines of the dies for performing each operation. The diemaker is given a sample of the part to be made or a part drawing, and is permitted to work out the details of construction as he sees fit. The measure of success obtained by this method depends on the experience and skill of the diemaker. The writer believes, however, that it is a better practice to have all details worked out and shown clearly on the drawings before the actual machine work is begun. One advantage of the latter method is that more accurate estimates of the cost of the equipment can be made.

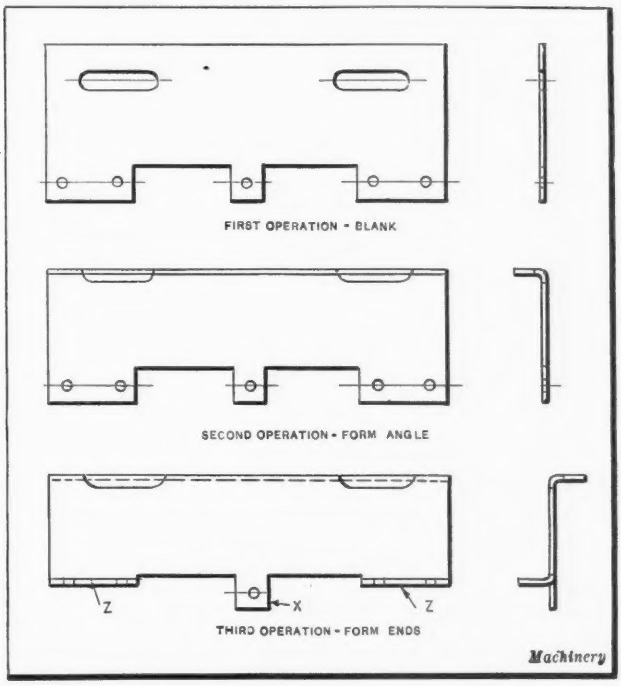


Fig. 1. Steps in the Production of a Sheet-metal Cover

The dies required for blanking, piercing, and forming a sheet-metal cover are shown in the accompanying illustrations. These illustrations also give a good idea of the type of drawing required by the toolmaker. The sheet-metal cover is shown in Fig. 1 as it appears after each of the three major operations. The covers are first sheared to size from flat stock, after which they are put into the notching and piercing die shown in Fig. 3. After the piercing and notching operations, the pieces are bent, as indicated by the second-operation diagram in Fig. 1, by the forming die shown in the upper view of Fig. 2. The final bending operation is then performed as shown in the lower view of Fig. 2.

Referring to the detail construction of the die shown in Fig. 3, *B* is a cutting die, secured to the base *A* by machine screws (not shown in the illustration). The corner pieces *C* and *D*, which are secured to the top face of the holder, serve to locate the blank in the correct position for notching. The two spring pins *E* serve to push or hold the work back against the locating pieces *C* and *D*. This method of locating the work insures uniform positioning of the pierced holes and notches.

The collars *F*, which are pinned to the spring pins, allow the latter members to spring forward for a distance of only about 1/16 inch when the work is removed from the die. In placing the work in the die, it is slipped into the corner gages *C* and *D*, and then pressed down against the chamfered ends of the spring pins until it snaps into the correct position. The punch-holder *G* contains a block *H* which is held in position by machine screws. On block *H* are mounted the two large punches *J* and *K*, which notch the front edge of the work while the two punches *L* cut the elongated holes in the plate, and a group of five round punches *M* pierce the small holes.

All the punches are fitted into the block *H* before it is placed in the punch-holder *G*. Screws at the front side of holder *G* are used to clamp punches *J* and *K* against block *H*. These punches are also locked in the block in such a manner that they will not be loosened or pull out. The punches for the elongated slots and for the small holes are headed over at the top to prevent them from being pulled out of the block. The stripper plate *N* forces the work from the punches as it ascends after the holes are pierced. The screws *P* prevent the stripper plate from sliding off the punches.

As the punches descend, the stripper plate *N*, being suspended slightly below the cutting edge of the punches, holds the work down on the die while it is being pierced and notched. The stripper plate springs *Q* are compressed when the piercing and notching operation takes place. The work has a tendency to cling to the punches as they ascend, but is prevented from doing so by stripper plate *N*, which is actuated by springs *Q*. The finger grooves at *X* and *Y* permit the operator to grip the work and lift it from the die. The notching punches *J* and *K* have a step-down surface at *Z*, the object of which is to allow the ends of the punches to enter the die-holder before their cutting surfaces come in contact with the work. With this construction the punches are backed up or braced so they will not spring away from the work. Guide pins at *W* are used to hold the punch-holder and die-holder in accurate alignment.

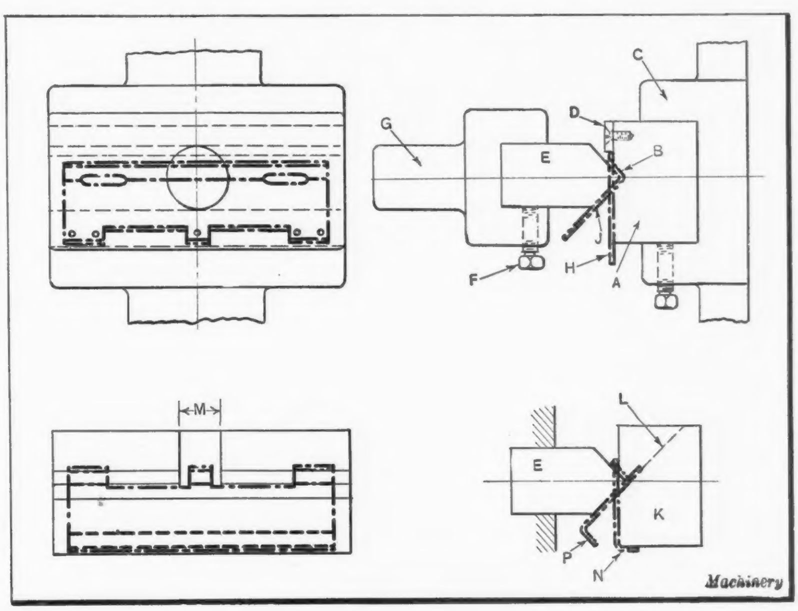


Fig. 2. Die for bending Part shown in Fig. 1

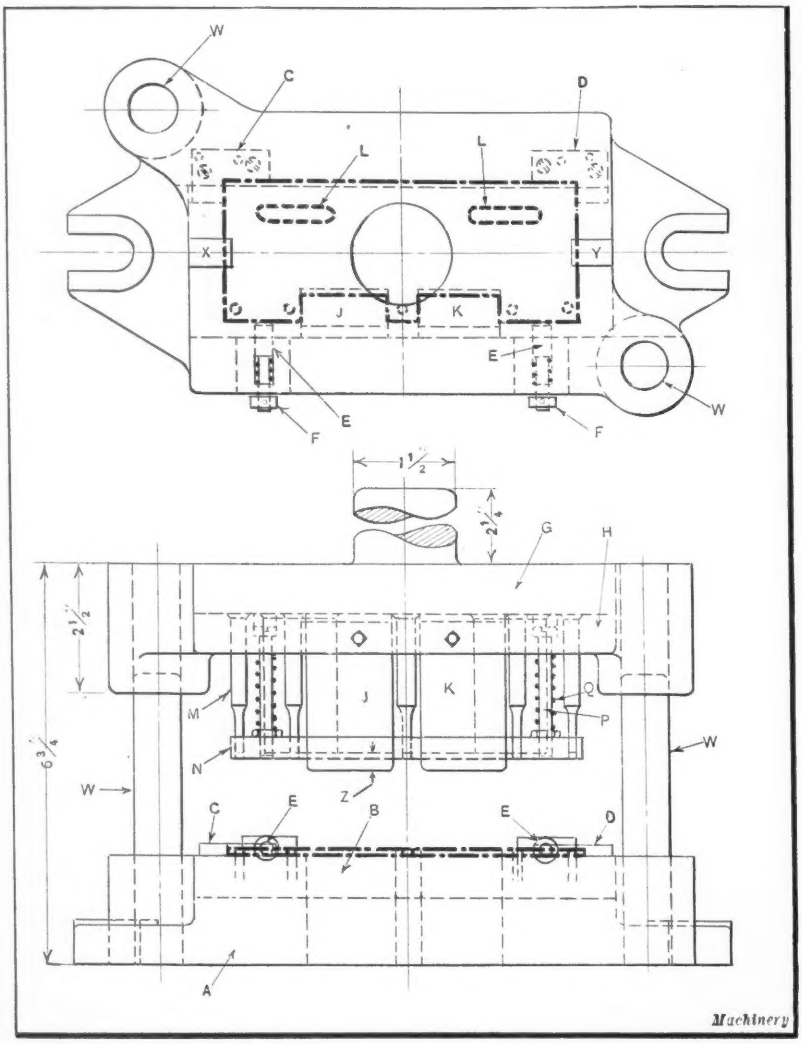


Fig. 3. Notching and Piercing Die used in producing Part shown in Fig. 1

The second operation—that of forming the angle as indicated in Fig. 1—necessitates the use of a V-die as shown in the upper view of Fig. 2. The die member *A* has a groove *B* of the required angle. A stop-plate *D* is secured to the top face of die *A*, against which the back edge of the work is located. The punch member consists of a block *E* which matches the die groove. To complete the forming of the part, the opposite side is bent up on the same forming punch by locating the work in the position shown by the heavy dot-and-dash lines at *N* in the lower view. Punch *E* is thus employed for both bending operations, but a different die member *K* is used for the second operation. Die *K* is beveled at *L* for a length *M* at the center so that the end of the work not formed will remain flat while the ends *Z*, Fig. 1, are being bent or formed.

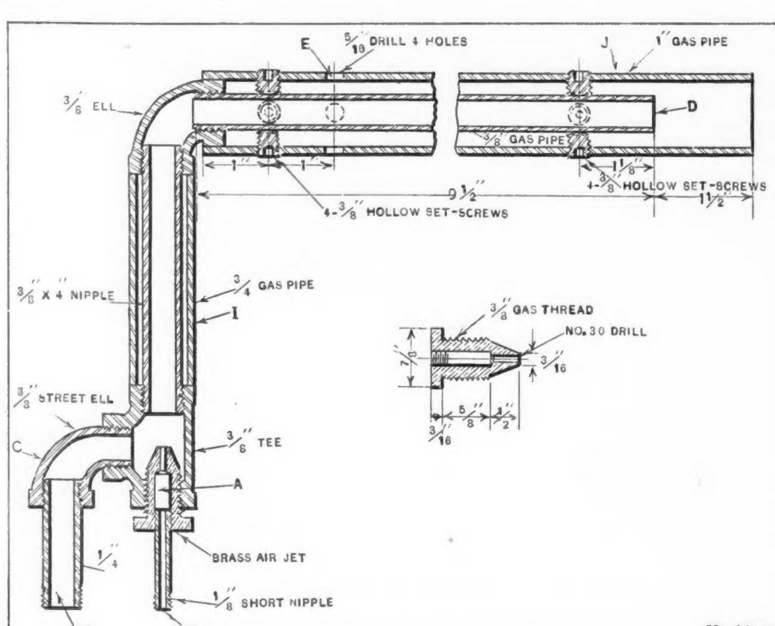
* * *

EASILY CONSTRUCTED GAS TORCH

By BRUCE DEVEREAUX

A gas torch using illuminating gas and compressed air, which will develop an exceptionally high degree of heat and is almost impossible to blow out, is shown in the accompanying illustration. Anyone having had experience with the ordinary type of torch will appreciate the latter feature. The torch, with the exception of one part, is made up of standard pipe fittings and stock set-screws. It can be easily made by anyone having access to an engine lathe. Sufficient heat is developed to easily melt a half-inch cold-rolled steel rod when it is placed in a corner which is formed by two fire-bricks resting on the brazing table.

The brass inlet jet *A* is practically the only part that requires any lathe work. This jet is drilled for high-pressure air, the pressure used being about 100 pounds per square inch. The 3/4-inch gas pipe *I* is used simply as a means of enlarging this section of the device in order to make it easier to hold in the hand. The 1-inch pipe *J* which covers the discharge nozzle is of vital importance. The gas and air mixture, rushing from the end of the small pipe *D*, draws in additional air through holes *E*, which mixes with the gas coming from the small pipe. This mixture ignites and burns inside of the large pipe, causing the end to become red hot and remain so as long as the torch is in operation. This heated end of the pipe tends to keep the gases burning, and makes it difficult to blow out the torch. If the outer shell or pipe *J* is removed, the temperature available will drop approximately 500 degrees.



Torch using Illuminating Gas and Compressed Air

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STANDARDS FOR GRAPHIC PRESENTATION

In 1914, the American Society of Mechanical Engineers organized a joint committee to develop standards for graphic presentation. This committee was made up of representatives of four organizations. It published its first and only report in 1917. This report was so favorably received that it has been reprinted several times. In 1921, the Management Division of the society took over the work, enlisting the cooperation of the Society of Industrial Engineers, the American Statistical Association, and the Taylor Society. These groups have decided that the work should be so broadened that national standardization on the subject could be brought about. Hence the American Engineering Standards Committee—the national clearing house for industrial standardization—whose procedure insures that the desired consensus of opinion will be effectively reached for the benefit of all interested parties, has now been asked to take this work in hand.

The British Metal-working Industries

From Machinery's Special Correspondent

London, July 17

IN the engineering field, the opinion is now general that the last two months have witnessed a set-back that was to a great extent, unexpected. While certain industries, such as the automobile plants, have maintained an exceptionally good position, and while there are to be found a few very active firms in almost every branch of engineering, the general experience gives evidence of a continuation of the depression.

The Machine Tool Industry

The machine tool industry fails to show any marked improvement, although the majority of the leading firms appear to have a fair amount of work in hand. Buyers are not very much interested in fairly good, moderate-priced machines, and they are not at all interested in cheap machines. It is the best quality and latest improvements that command the bulk of the orders that are being placed at the present time.

Makers of lathes of about 12-inch swing are fairly busy with government and overseas orders, and the majority of makers of grinding machines are better occupied than manufacturers of most other standard machines. The demand for railway shop machine tools is fair, and recent months have seen new designs of machines for railway wheels and axles. The latest machine of this type is now in operation at the plant of the Leeds Wheel & Axle Co., Ltd., and is used for turning, boring, and bossing wheel centers of either the disk or spoke types. All the operations are carried out simultaneously, with seven tools cutting at once; as the center is finished at one setting, much time is saved, and the gain in accuracy is considerable. The machine, which is of the vertical turning and boring mill type, can handle wheel centers up to 3 feet 5 inches in diameter, and the production time is dependent entirely upon the roughing and finishing boring operations, which naturally occupy the longest time.

Overseas Trade in Machine Tools

The somewhat serious drop that occurred in the exports of machine tools during April did not continue in May, and the position was partly retrieved. However, the improvement was confined to tonnage, since the total value of machine tools exported during May was £140,432, a value slightly below that of April. The tonnage in May rose by 130 tons above the April figures, reaching 1286 tons. The value per ton of exports in May was £109, as compared with £124 in April. The imports of machine tools rose slightly in both tonnage and value during May, the figures being, respectively, 373 and £55,175, as compared with 297 tons and £50,785 in April. The value per ton of imported machine tools fell in May to £148 from £172, recorded in April.

Compared with the averages of 1911 to 1914, the exported tonnage of machine tools is, for the present year, 5 per cent greater, while the value is over 90 per cent greater. Imports of machine tools are 24 per cent greater in tonnage and 74 per cent greater in value than the average during the period mentioned. In May Great Britain's best customers for machine tools were India, with £57,000 worth; Australia, with £16,000; Russia, with £14,000; and France, with £11,000. Egypt, China, New Zealand and South Africa bought tools to the value of from £3000 to £5000.

General Engineering Field

Business in the general engineering field is extremely irregular, and owing to the low level of general industry, developments in many directions are retarded. Structural engineers have experienced a disappointing time during the last few weeks, and for bridge work and other large-scale structural undertakings, few contracts are expected in the near future. Electrical engineering firms continue to maintain fairly prosperous conditions, and are also looking forward to increased developments. Boiler makers can show little in the way of orders in hand, but makers of oil engines are better placed, and orders for all powers from the smallest up to 250 horsepower are in evidence. Foundry engineers are also receiving more orders, especially from overseas.

The railway car shops are regularly engaged on work for home, colonial, and foreign railways. Locomotive builders are also better off for orders. The North British Locomotive Co., Ltd., has thirty-five locomotives in hand for the Egyptian railways. The same company also has in hand thirty passenger locomotives for the Southern Railway and twenty-five locomotives for the London, Midland & Scottish Railway. These works expect to be fully occupied for the entire year. Important orders for power transmission schemes that will link up South African mining areas have also been placed.

The Automobile Industry

In the automobile industry, the promise of a record season appears to have been entirely fulfilled. Productive activity continues unabated, and with factories running day and night, new cars are being built in great quantities. A gratifying feature is that, while catering to the peak demand at home, British manufacturers are effecting increased export deliveries, not only to the Continent, but to numerous Colonies, among which India figures rather conspicuously. That the coming season is not being neglected is indicated by the demand from small tool makers for tooling equipment required in connection with new or improved models, and the fact that several firms are contemplating extensions to their factories. One well-known Coventry manufacturer expresses the hope of being in a position to employ from 2000 to 3000 additional hands within the next two years.

The Shipbuilding Industry

The serious outlook in shipbuilding is now more apparent, since recent launchings have disposed of much of the work in hand, and litttle new work is being started. It is probable that the complete output for this year will be much below the average, despite the record set up during the first four months of the year. The Clyde, North East Coast, and the Mersey show practically identical conditions as to rapidly approaching slackness, although the Clyde is meeting with slightly more success in the acceptance of a few tenders for cargo vessels. These orders, though somewhat unremunerative, show that concerted efforts to combat the competition of the German shipbuilding combine have already met with some measure of success.

Centenary of British Railways

The centenary of the opening of the first steam railway in England was celebrated early in July. George Stephenson's locomotive No. 1, which pulled the first passenger train between Stockton and Darlington, repeated its performance of 100 years ago and pulled replicas of the type of coaches then used. Locomotives and rolling stock showing the development of railway transport followed locomotive No. 1, all the railways of Great Britain contributing to the procession. The celebrations were organized by the London & North Eastern Railway, which includes the old Stockton and Darlington railway.

Current Editorial Comment

in the Machine-building and Kindred Industries

COOPERATION IN THE SELECTION OF MACHINE TOOLS

The task of the equipment engineer in a large plant engaged in quantity production is not an easy one. Four factors must be considered in selecting machines; the investment cost, the labor cost of the product, the floor space required and the supervision expense.

It is impossible to find all these requirements combined in one machine. Generally, the lowest possible first investment cost can be attained only by increasing labor costs and floor space; the lowest possible labor cost and floor space usually require a greater investment and greater expense for supervision, because a cheaper grade of labor is employed and more complicated machinery is necessary.

Because of these conflicting conditions, unusual judgment and knowledge of manufacturing conditions are required of equipment engineers. They must consider factors that the builder of machine tools is not obliged to consider; and the closest cooperation, therefore, is essential between the builders and designers of machine tools, and the equipment engineers and production managers of large quantity-production plants.

Some machine tool builders now send their designers on inspection tours to large automobile plants to familiarize themselves with the conditions under which machine tools are being used in these shops. Such cooperation is generally welcomed by automobile manufacturers, and some say they wish the practice were more general. It enables the machine tool designer not only to study carefully the reduction in labor costs, which he may be too likely to look upon as the primary factor in designing a new machine; but also to consider the other three factors that affect the choice of the equipment engineer.

* * *

STANDARDIZING JIG BUSHINGS

It is not always the biggest and most conspicuous items of machine shop equipment that can be most easily and most profitably standardized. Frequently it is the smaller details that best lend themselves to standardization. Fifteen or twenty years ago there was no standard whatever for jig bushings. Then, when a draftsman designed a jig, he dimensioned the bushing according to his fancy at the moment. The dimensions, of course, were based upon his past experience, and the jig bushing was satisfactory for its purpose; but unless the draftsman had some system of his own, no two bushings were made exactly alike, and the toolmaker in the shop made each bushing for the jig as a separate unit.

Later, some of the larger companies had tables prepared for their tool designing departments, specifying certain standard dimensions for the jig bushings used in their own shops. In this way, bushings could be made up in advance at a considerable saving in cost, a number of bushings of the same size being made at one time.

Quite recently, standardized jig bushings have been placed on the market as a commercial product. Those who use them find that a comparatively small number of sizes will meet all requirements, that there is a saving in first cost, that interchangeability is always assured and that the individual tool-room of the plant is relieved of the problem of producing parts that can be made cheaper in quantity outside. The drafting-room, being provided with a standard data sheet of jig bushings, is relieved of the work of designing bushings for every job.

In an automobile plant, during the rush to procure the tools required for a new car model, jigs were ordered from a considerable number of toolmaking concerns in the vicinity. The tools were put to use, and everything was satisfactory until it became necessary to replace some of the jig bushings. Then it was found that bushings of the most varied dimensions had been used, and that every replacement meant the making of a bushings to suit each individual jig. This apparently unimportant factor caused a serious loss of time which would have been saved if standard bushings had been used.

* * *

DO YOU WANT SPECIAL WORK?

The experience of several machine tool builders has convinced us that more business can be obtained for machine tool shops than many managers believe possible, and we do not consider as too optimistic the recent statement of the executive head of a machine tool plant, "There is business to be had, if you go after it"; because he has proved it by his own experience.

The shop referred to has built a standard line of machine tools for years, but until lately was operating at about twenty per cent of capacity. Some six months ago it was decided to build special machine shop equipment in addition to the standard line, and to give the customer what he wanted, irrespective of whether his demands were for entirely special types or standard machines with special attachments. More salesmen were put on the road, the advertising was materially increased and the sales efforts in all directions were augmented. The results of this new policy have been most encouraging. In the first five months of 1925, the orders booked equalled the entire 1924 business; twice the number of men are employed in the shop, and the losses of the past year have been converted into profits.

The executive quoted above, added: "Business in the machine tool and kindred lines is not dead by any means. There is plenty to be had if you go after it. It may not be always the kind of work that you would prefer, but there is business to be had for which the equipment of a machine tool shop and the experience of a machine tool organization is well suited."

* * *

THE CHANGE IN INSPECTION METHODS

Gage manufacturers have found that the demand for their product is smaller now, in proportion to the production of the plants in which gages are used, than it was from five to eight years ago, the so-called "100 per cent" inspection methods which then prevailed being in less general use. There are several reasons for this. One is the effort to reduce costs, including inspection expense; another is that with a reduced output in most of the mechanical industries, more highly skilled labor is employed in the shops, making it possible to lessen the inspection. During and immediately after the war, when the shops were manned largely with unskilled help drawn from all kinds of occupations, the "100 per cent" inspection was almost imperative; now, less stringent methods insure the desired quality in the product. In the high-pressure period, the foremen were so occupied with providing means and methods for production that they could devote but little attention to keeping up the quality of the product. This was left entirely to the inspectors. At present the tendency is increasing to hold the foremen responsible for quality, thereby reducing the inspection expense.

Production Methods in a Tractor Plant

Typical Operations Illustrating the Quantity Production Methods Used in Building Agricultural and Industrial Tractors at One of the Plants of the International Harvester Co.

AUTOMOTIVE engineers in general often think that the quality of workmanship in the engines of agricultural tractors is not equal to that of passenger cars. This, however, does not apply to the product of the Tractor Works of the International Harvester Co., Chicago, Ill., because it has been proved that the limits of accuracy specified on certain engine parts are closer at this plant than in some of the foremost automobile shops. Operations are carried out under quantity methods that are usually associated only with the automobile industry; some of the most interesting of these operations will be described in this and in a succeeding article. The daily production at this plant averages about eighty tractors. All parts used in building the tractors, with the exception of ball bearings, magnetos, carburetors, bolts, and a few brass pieces, are made by the International Harvester Co.

Steering Knuckle Operations

Steering knuckles are finished complete from rough forgings as they are passed along a roller conveyor extending between two rows of machines, as illustrated in Fig. 1. On this conveyor are several simple carriages made up of angle-irons and flat stock. The steering knuckles are held on an angle-iron at each side of the carriages by hooking the yoke over the legs of the angle-irons. It is an easy matter to push the carriages from machine to machine.

The first operation consists of centering both ends of the steering knuckle in a vertical-spindle machine, with the work held in a fixture in which it is located from the shank and the yoke. Then the steering knuckle is passed to an engine lathe equipped with a special turret toolpost for rough-turning the shank, after which the shank is finish-turned in a semi-automatic lathe. The next operation is performed under one of the three drilling machines shown in Fig. 1, and consists of drilling, reaming, and counterboring the king-pin hole. Quick-change chucks are used on these machines in order to permit rapid substitution of tools. The work is located from its centers in a jig which is rotated 90 degrees after loading, to bring the work into the drilling position.

After this operation, the steering knuckles are carried on to the two milling machines shown at the right-hand end of the illustration, where the yokes of two knuckles are straddle-milled at one time in each machine. The machines are equipped with two fixtures and four 14-inch milling cutters having inserted blades. A thread is next cut on the shank in a turret lathe which is equipped with a special holding fixture and a die-head, and in the final operation, all the important diameters are ground.

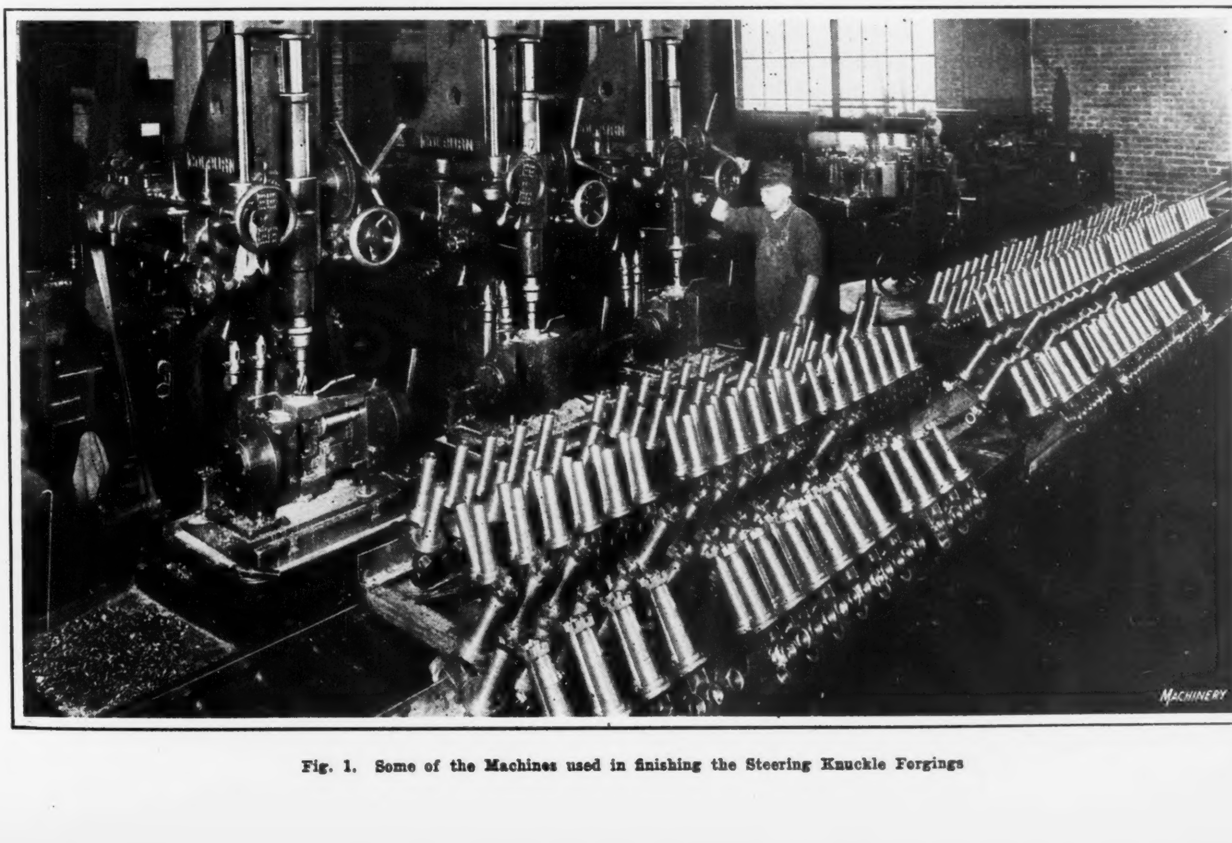


Fig. 1. Some of the Machines used in finishing the Steering Knuckle Forgings

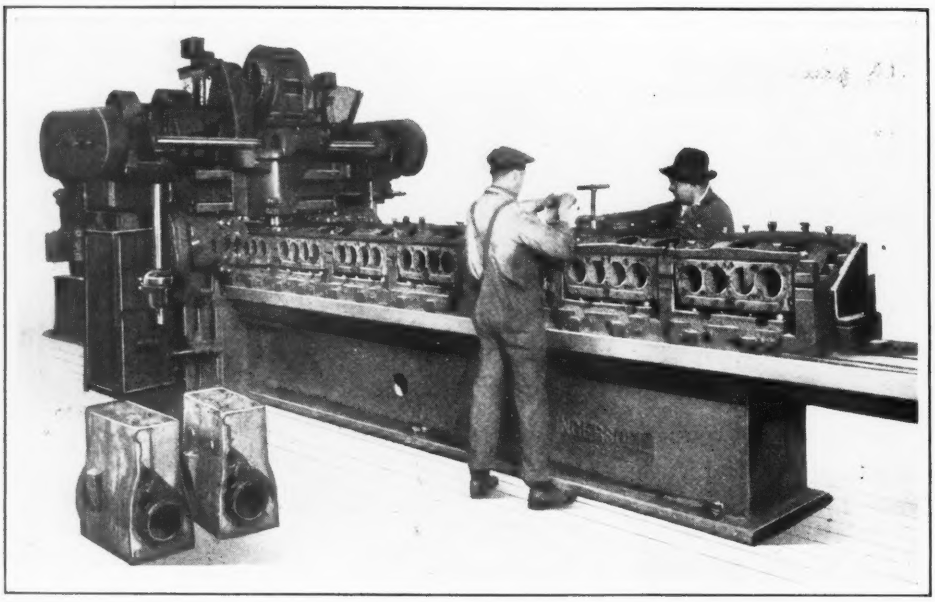


Fig. 2. Rough- and finish-milling the Top, Bottom, and One Side of Seven Cylinder Blocks at One Time

Various surfaces on the top, bottom, ends, and sides of the cylinder blocks are finished in two operations performed on planer-type milling machines. In the first operation, the surfaces on the two ends and on one side are finished, and then the cylinder blocks are brought to the machine shown in Fig. 2. Here seven castings are clamped at one time in fixtures on the machine table for milling the top, bottom, and the side shown uppermost. On both the right- and left-hand sides of this machine, on the front side of the housings, there is a horizontal head equipped with two interlocking cutters. The cutters on the left-hand side mill the top of the cylinder blocks, and those on the right, the bottom.

The head on the cross-rail is provided with a cutter located at an angle for milling the hand-hole cover pads, and another that finishes a horizontal surface on the same side of the blocks. On the rear of each housing is mounted a head that carries a cutter large enough in diameter to finish-mill the entire top or bottom of the cylinder block.

Line-reaming the Cylinder Blocks

One of the most important jobs in the crankcase department consists of line-reaming the crankshaft and camshaft bores in the cylinder blocks. The diameters of these bores vary, the maximum size crankshaft bore being at the left-hand side of the work as it is placed in the jig, and the maximum size camshaft bore at the right-hand side. The maximum size crankshaft bore is about 8 inches in diameter, and the maximum size camshaft bore, 2 inches in diameter. Two machines of the type shown in Fig. 3 are used for the operation, the first one taking roughing cuts, and the one illustrated, semi-finish and finishing cuts. The crankshaft bores are machined from the left-hand side by cutters in bar *A*, and the camshaft bores by cutters held in bar *B*.

Each boring-bar is fitted with two pilots, such as shown at *C* and *D*, which fit snugly into hardened sleeves in the jig, to guide the cutters accurately for the operation. Two holes are bored with the left-hand bar, there being four cutters for each hole, two of which take the semi-finishing cut, and the other two, the finishing cut. The right-hand hole bored with these cutters is of a size small enough to permit passing the cutters through the left-hand hole without interference. The boring-bar for the camshaft bearings is equipped with three sets of cutters for boring as many different sized bearings. Each of these bearings is sufficiently smaller than the one preceding so that the cutters can be passed through the necessary holes without making any adjustment in their radial settings.

For this operation, the bottom of each cylinder block seats on hardened and ground steel strips, while finished bosses on the back of the block are clamped against stops by means of two screws on bar *E*. This bar is dropped into place after the work has been pushed into contact with the stops. Location of the work lengthwise in the fixture is insured by two stationary blocks on the left-hand end and an adjustable block at the opposite end. Overhead screws are tightened to hold the cylinder block firmly on its seat.

Routing out the Combustion Chambers in the Cylinder Heads

Fig. 4 shows an operation performed on the combustion chambers in the cylinder heads to eliminate all rough spots that might start the formation of carbon when a tractor is put into service. It will be seen that the machine is equipped with four tools of a special shape for routing all the combustion chambers at one time. These tools are equipped with inserted blades which are rounded at the lower outer corner to produce the desired shape in the combustion chamber.

The cutters are smaller in diameter than the combustion chambers, and in the operation they are first fed to depth, after which the machine moves the work back to bring each chamber wall against a cutter and then imparts a combined sidewise and backward movement to the work so as to feed each chamber eccentrically around its respective cutter. At the end of the operation, the work moves forward to the position shown, and the cutters are raised to permit reloading. Longitudinal and transverse slides are incorporated in the table, and there are cams that impart the movement to these slides for feeding the work in the correct relation about the cutters. Cutters smaller in diameter than the combustion chamber are used because the sand in the cast-

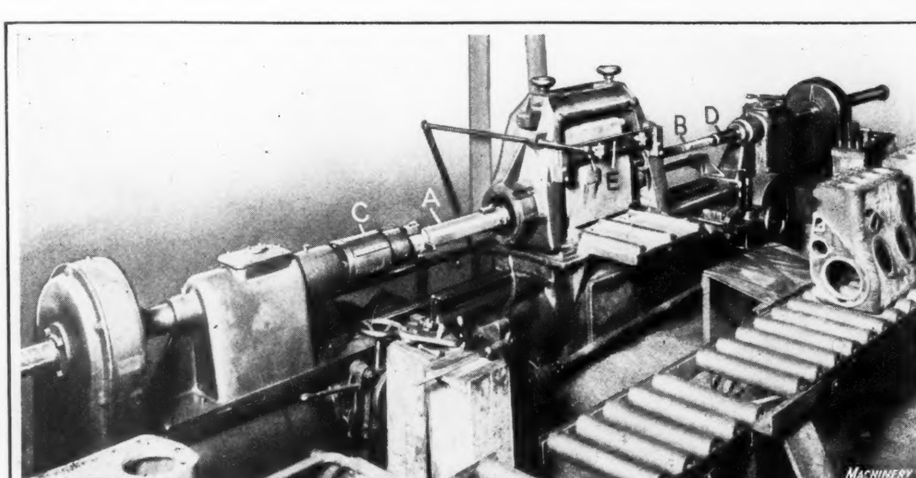


Fig. 3. Line-reaming the Crankshaft and Camshaft Bores in the Cylinder Block

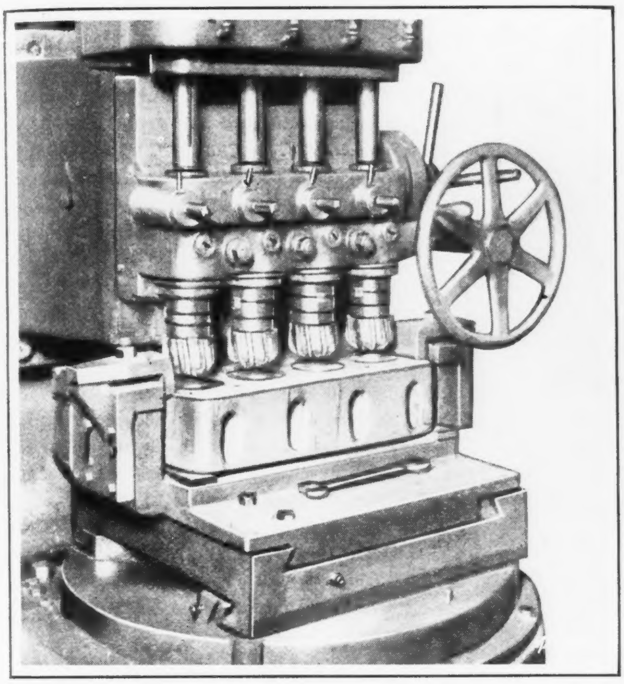


Fig. 4. Routing out the Combustion Chambers in the Top of the Cylinder Head

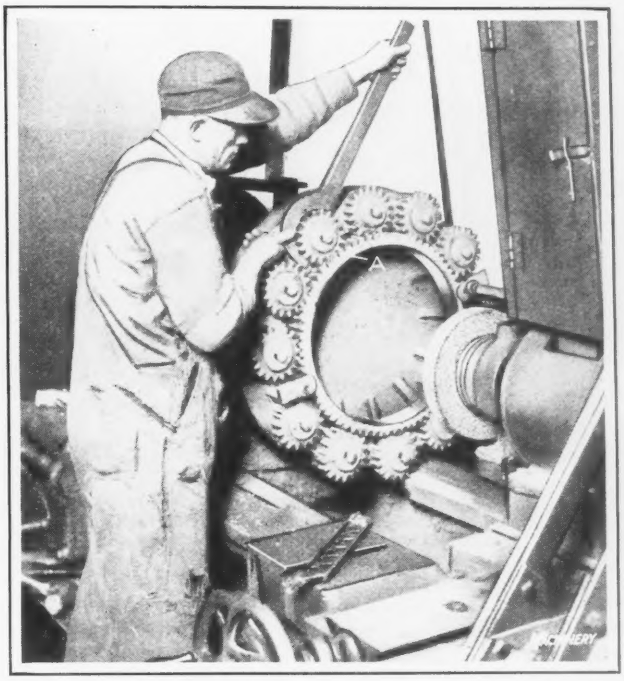


Fig. 5. Chucking Arrangement used in grinding the Internal Surface of a Bull Gear

ings would soon ruin full-diameter cutters. Holes previously reamed in the castings are used to locate them for the operation. The machine is a product of the Ingersoll Milling Machine Co.

Two Unique Grinding Operations

The main drive or bull gear of the tractor is of the ring type shown at *A* in Fig. 5, and is ground on the inside to a diameter of 16.637 inches within a plus limit of 0.003 inch and a minus limit of 0.000 inch. This operation is accomplished on a lathe equipped with a special grinding head and a chuck of unusual design, which insures that the internal surface of the ring gear will be ground accurately in relation to the pitch circle. Around this chuck are twelve pinions, 5 inches in diameter, having teeth of the same pitch as the work. The work is slipped into place with its teeth meshing with those of the pinions; then a spanner wrench is applied, as shown, to turn one of the pinions, and as it revolves it rotates the ring gear and the latter revolves all the remaining pinions. The pinions are mounted eccentrically on studs so that as they turn they tend to compress the ring gear, and thus hold it firmly for the operation. Two clamps are next tightened on the front of the gear to prevent it from sliding sidewise.

At the end of the operation, the spanner wrench is again applied to loosen the pinions. In order that the pinions can be quickly positioned for reloading, the teeth of the pinions that are closest to the center of the stud on which they are revolved, are suitably marked. The accuracy of this grinding operation is checked by means of the inside micrometer seen lying on the carriage of the machine.

Another grinding operation of particular interest consists of finishing a spherical seat to a radius of 3.913 inches on the back of differential pinions, as shown at *A*, Fig. 6. This surface of the pinions bears against a corresponding surface in the differential housing to take the back pressure, and for this reason must be true within close limits. The operation is performed on a standard machine provided with special equipment. The work is held on head *B*, which swivels in a horizontal plane, to swing the work past the grinding wheel, and as the work rotates on its own axis at the same time, the spherical surface is ground as it is brought in contact with the wheel.

Power for swiveling the work-head and for driving the work-spindle is delivered to the machine through pulley *C* by an overhead belt. From the pulley the power is delivered through shafts connected by knuckle joints to a worm in the swiveling work-head. This worm drives a worm-gear

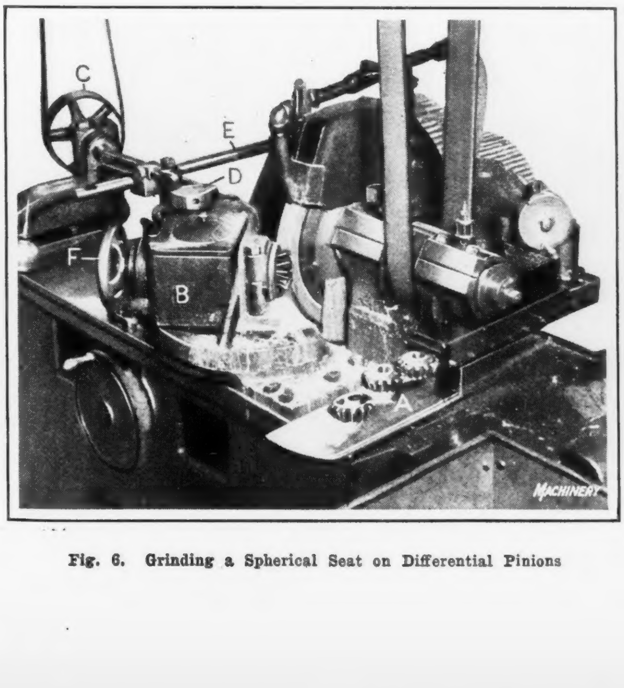


Fig. 6. Grinding a Spherical Seat on Differential Pinions

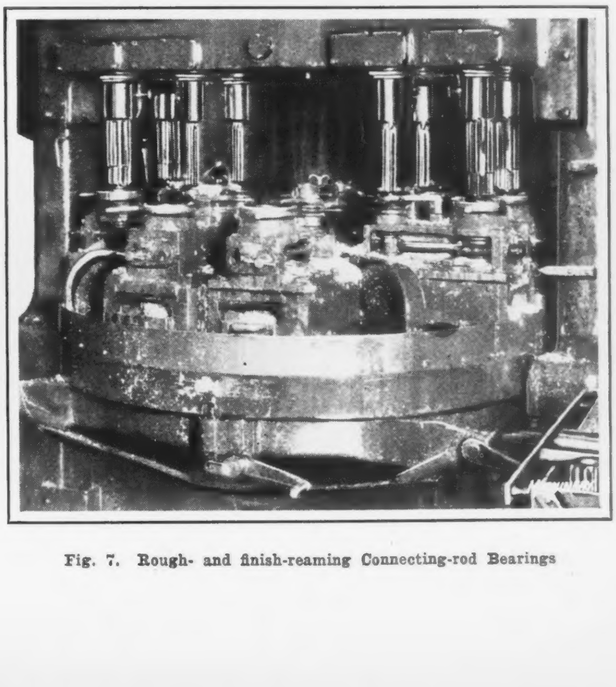


Fig. 7. Rough- and finish-reaming Connecting-rod Bearings

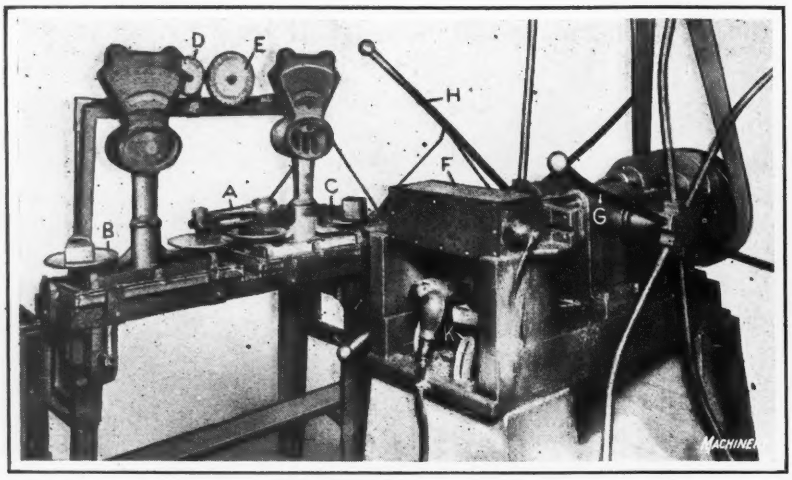


Fig. 8. Scales used in determining the Amount of Metal to be removed from Connecting-rods to obtain the Desired Weight, and Horizontal Drilling Machine used for removing this Metal

on the bottom of a vertical shaft, and at the top of this shaft there is a crank *D* which is connected by means of rod *E* to a stationary stud at the rear of the machine. Thus as crank *D* revolves, it causes the head to swing back and forth on its axis, which is directly in line with the grinding wheel. At the front end of the shaft on which the worm is mounted, is a bevel gear which drives a similar gear keyed to the work-spindle. The work is held in an expansion collet, operated by revolving handwheel *F*.

Producing Accurate Connecting-rods

A number of high-production methods of manufacture are carried out in the connecting-rod department, one of which is illustrated in Fig. 7. This operation consists of rough- and finish-reaming the two bearings of the connecting-rods, and is performed in a machine equipped with eight tool-spindles arranged in two sets for simultaneously operating on four rods. The connecting-rods come to this machine after the bearing holes have been bored, the bolt and oil holes drilled, and the sides of the bosses milled. There are eight fixtures, the two in the front position being reloaded during an operation. All four tools on one side of the machine rough-ream the bearings of two rods, and those on the other side finish-ream the same bearings after the work has been indexed around the back of the machine into the second working position. With this arrangement, two rods are finished at each indexing of the machine. The table is raised to feed the connecting-rods to the tools. The large bearing hole is 3 1/16 inches in diameter, and the small bearing hole 1 7/16 inches. The connecting-rods are located in the fixtures by means of the two bolt holes and the bushings clamped on the bosses at the two ends.

Pistons and connecting-rods are not permitted to vary more than 1 ounce in weight when they leave their respective departments, and in addition, the connecting-rods must accurately check for center of gravity when balanced over a knife-edge. By taking such care in the manufacture, it is not necessary to match pistons and connecting-rods for the different cylinder bores of each engine, and any piston and connecting-rod bought as a repair part will be of the same weight as the original part within 1 ounce. To obtain accuracy of the connecting-rods with regard to weight, it is necessary to remove a certain amount of metal from the rods after they have been finished and the main bearing cap has been bolted on ready for assembling in an engine.

For this operation, the two ends of the connecting-rods are weighed on separate scales, as shown at *A*, Fig. 8. On the outer table *B* or *C* of each scale there is placed a weight equal to the amount that the respective end of the connecting-rod should weigh, and any variation from this weight is indicated by the dial on the scales. The operator who does the weighing stands behind the table, and as he determines the amount of metal that must be removed, he sets dials *D* and *E* accordingly, for the information of the operator who does the drilling. These dials are graduated identically on both sides in quarter ounces.

Near each end of the connecting-rods there is a boss into which a blind hole is drilled to remove the amount of metal necessary to obtain the correct weight. For this drilling, the connecting-rod is seated on the forward side of fixture *F*, and spider wheels *G* and *H* are successively turned to feed the drills into the bosses. At the front of this machine are two Pelouze laboratory scales to which are attached pans into which the drill chips slide. It is only necessary for the operator to watch the movement of the indicator on these scales to determine when he has removed enough metal from each end of a connecting-rod to obtain the desired weight.

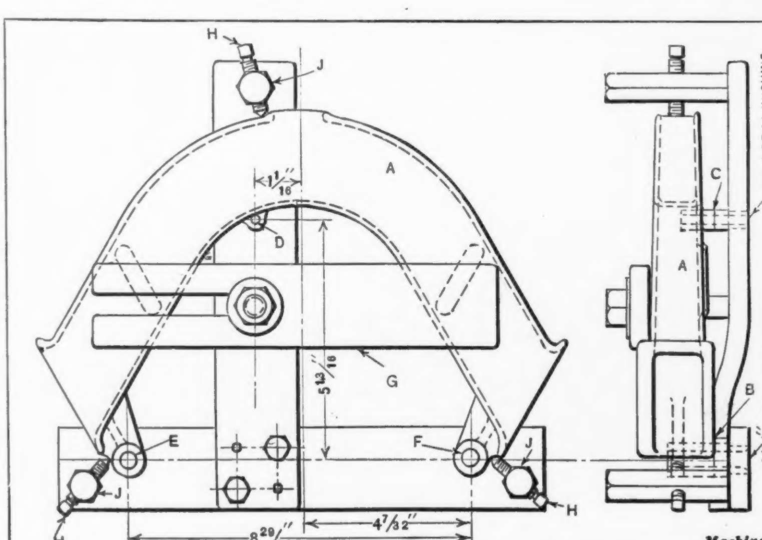
* * *

DRILL JIG FOR ALUMINUM CASTING

By ALFRED T. GREGORY

The jig here illustrated was employed in drilling the three holes *D*, *E*, and *F* in a lot of forty aluminum castings like the one shown at *A*. This limited number of castings did not, of course, warrant the construction of an expensive drill jig. The jig shown was made at very little cost, yet it proved sufficiently accurate to meet all requirements. It will be noted that the body of the jig consists simply of two pieces of flat stock fastened together with dowel-pins and cap-screws. The three pieces of hexagonal stock *J* serve as feet for the body of the jig.

The only finished surfaces on the casting *A* were the bottom faces of the lugs at *B* and *C*, which were finished on a disk grinder. The bushings which guided the drills were made with enlarged ends having diameters equal to the corresponding diameters of the lugs. The castings were located by aligning each lug with its respective drill bushing, after which the clamp *G* was tightened down to hold the casting in place. The final fastening of the casting was accomplished by tightening the three set-screws *H* against the work with the fingers. These set-screws simply served to prevent the work from slipping out of position, and were not tightened sufficiently to cause the work to slide or slip under clamp *G*.



Jig used in drilling Aluminum Casting for Aviation Engine

EXTENSION TOOL-HOLDERS

By MARTIN J. SCHNEIDER

The extension tool-holder shown in the three views of Fig. 1 is used primarily for under-cutting and T-slotting operations on a planer. The casting *A* of the holder is secured to both heads of the planer, as shown in the upper right-hand view. The two planer heads, thus tied together by the holder, are fed as a unit by the feed-screw of one head, the feed-screw of the other head being removed or thrown out of gear. The cutter-bar *B*, which is 4 3/4 inches diameter by 60 inches long, is provided with a clapper-box *D*. The weight of the cutter-bar and casting *A* is counterbalanced by weights at the end of a flexible cable, which facilitate the operation of the machine, and prevent the tool-holder from being accidentally dropped on the work.

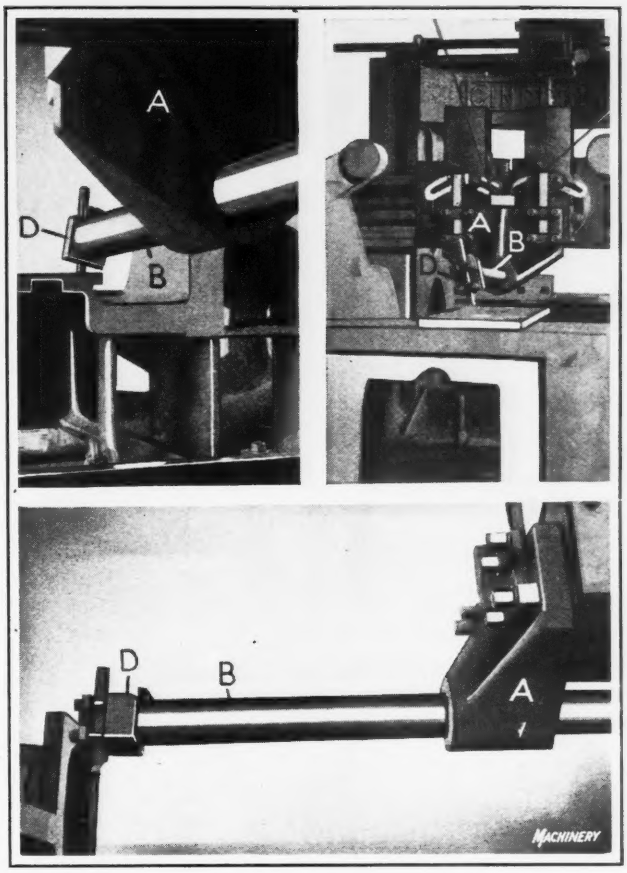


Fig. 1. Planer equipped with Extension Cutter-bar

The tool-holder shown in Fig. 2 was designed primarily for planing the face angle and under-cut of way-drill uprights. The body *A* of the holder is a steel casting, 36 inches long by 10 inches wide. This holder is attached directly to the slide of the planer, which is drilled and tapped to receive two 1-inch studs. Referring to the central view, it will be noted that the lower end of the holder is set back so that the point of the tool is in line or a little in back of the face of the slide. This feature permits the tool to spring away from the work when the pressure is too great, as in the well-known gooseneck tool.

INDUSTRIAL CONDITIONS IN RUSSIA

According to a statement given out by the Russian Information Bureau, 2819 Connecticut Ave., N.W., Washington, D. C., Russian industries are gradually recuperating, the textile industry at the present time running at about 70 to 75 per cent of the pre-war volume of production. It is stated that large orders for textile machinery will soon be placed in England and later in the United States, and that when the mills are equipped with this machinery, the pre-war rate of output will be exceeded. There is in Russia a marked shortage of textile goods, as compared with the demand, and this shortage is expected to increase this fall, if the present crop prospects materialize. It is also stated that Persia imports a considerable amount of textiles from Russia. For the reliability of these reports, it is, of course, impossible to vouch, because so many contradictory statements have come out of Russia, and until Russia is entirely opened up to the outside world, with complete freedom of travel, no very accurate picture of the conditions there can be obtained. A fact that seems to substantiate the statements regarding a gradual recuperation of Russia is that a considerable number of machine tools have been exported from here to that country during the past year. This demand appears to continue, but in some cases the terms asked for have not been satisfactory to American manufacturers, who cannot afford to extend the credit requested.

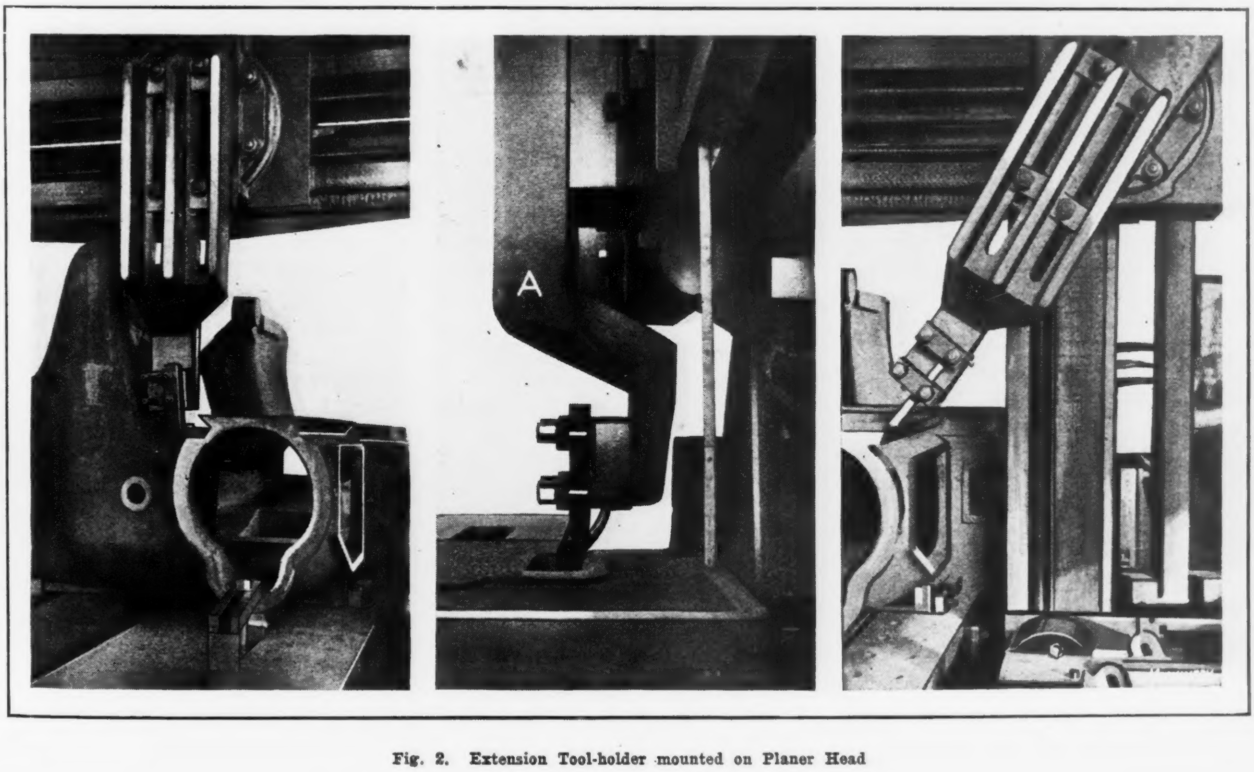


Fig. 2. Extension Tool-holder mounted on Planer Head

HOBBING COARSE-PITCH SPROCKETS

By CARL G. OLSON

The hobbing of coarse-pitch sprockets ordinarily requires hobs of a large diameter, as otherwise there will not be a sufficient number of teeth in the hob to remove the stock freely and generate a true form. In order to swing a large

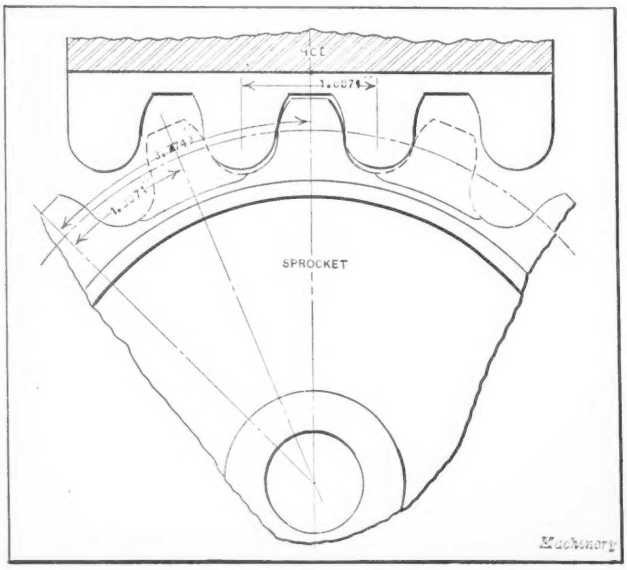


Fig. 1. Profile of Hob and Segment of Generated Sprocket

hob, it is obvious that a large hobbing machine must be used. Recently a manufacturer required a hob for cutting 3 3/4-pitch block chain sprockets. The hob was to be used in a 36-H Gould & Eberhardt hobbing machine of sufficient capacity to swing a hob 7 inches in diameter. The problem of providing a suitable hob was submitted to the Illinois Tool Works, of Chicago. This company found that it would not be practicable to use an ordinary 7-inch diameter hob, and so designed a special hob, which is now being used with satisfactory results.

The design of the special hob was based on the fact that the contour of a block chain sprocket is similar to the contour of a roller chain sprocket with every other tooth cut away. Thus it is evident that a hob similar to a roller chain sprocket hob could be used by having the normal lead of the hob equal to only one-half of the circular pitch of the sprocket, and the teeth designed to generate the required profiles. A hob of this design would have twice the number of teeth in the cutting zone, and could therefore be made of a much smaller diameter than a hob having a normal lead equal to the circular pitch of the sprocket.

In Fig. 1 is shown a profile of the hob and of the segment of a generated sprocket. The blanks must be cast to the required shape, with recesses between the teeth and with stock for finishing only on the tooth faces. In Fig. 2 are shown a blank, a hob, and the finished product, which is an 8-tooth sprocket for a heavy 3 3/4-pitch block chain. In Fig. 3 are shown the hob and the work, mounted on the hobbing machine, which is geared to cut sixteen teeth instead of eight. The hob, running at a speed of 60 revolutions per minute, with a feed of 0.080 inch per revolution of the work, cuts the teeth in eighteen minutes, floor to floor time.

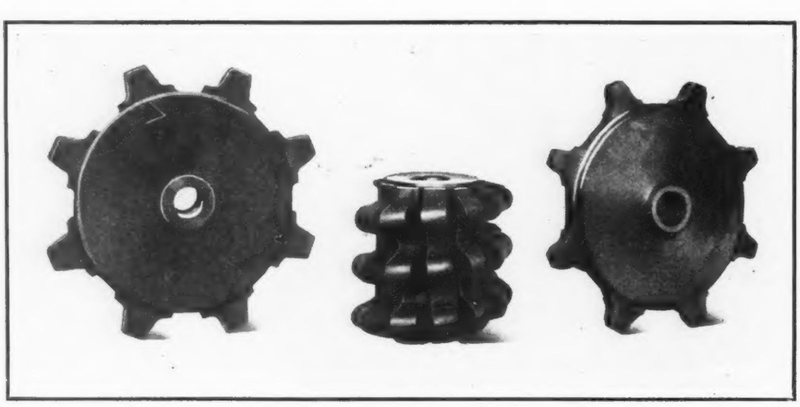


Fig. 2. The Blank, Hob, and Finished Sprocket

* * *

ILLUSTRATIONS FOR ARTICLES FOR PUBLICATION

Articles that are to be submitted to technical journals for publication should be carefully examined by the author before they are placed in the mail. The author's name and address should be placed on the manuscript and on all drawings and illustrations accompanying the article, whether they are enclosed with the manuscript or mailed separately. The address and name should be clearly written, so that there can be no mistake about the spelling or street number.

Drawings should be made to scale like regular mechanical drawings. Pencil drawings are satisfactory, if the lines are made dark enough to be in sharp contrast with the paper. White paper is always preferable, although paper with a slight tint can generally be used; but it is usually impossible to make a good reproduction of a drawing made in

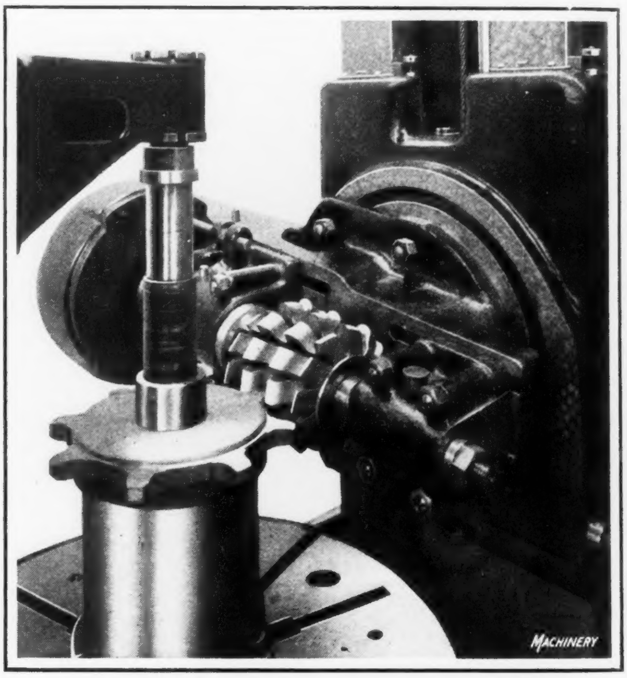


Fig. 3. The Hob and Work mounted on the Hobbing Machine

pencil on colored paper, particularly yellow paper.

Blueprints should be made as dark as possible with the white lines showing up in sharp contrast. Perhaps one of the most common faults in making blueprints is failure to wash the blueprint, directly after printing, in clean water, free from chemicals. If this is not done, the blueprint, while it may appear perfectly satisfactory at first, will become so faded after a few minutes exposure to the light that it will be practically useless. Ink tracings can, of course, be used, and good photostat illustrations are satisfactory.

Ordinarily, photographs should not be less than 5 by 7 inches, and larger photographs are desirable, although smaller sizes can sometimes be used, if they are of very good quality. Pencil or ink marks or reference letters should never be placed directly on a photograph. If it is necessary to refer to different parts by reference letters, carefully trace the main outlines of the photograph on a piece of thin paper, and place the letters on this paper.

Cutting Speeds of Crank Shapers

By K. H. CRUMRINE, Engineer, Cincinnati Shaper Co., Cincinnati, Ohio

CUTTING speeds in feet per minute are usually considered of vital importance in preparing for work or calculating production time on lathes, screw machines, and kindred equipment having tools that, on entering the work, cut continuously until each operation is finished. They are not, however, so generally taken into account on machines such as the crank shaper on which the cuts are intermittent, each alternating wth a non-productive return stroke of the same or less duration than the cutting stroke.

This is no doubt due to the fact that the method of determining the actual cutting speed of the tool on a crank shaper is not generally understood, it being somewhat complicated and governed by a number of factors, some of which are highly variable, and all of which have a direct bearing on the cutting speed of the ram and tool.

These determining factors, briefly listed, are as follows:

1. Length of stroke.
2. Number of strokes per minute (same as number of rotations of driving gear per minute).
3. Length of rocker arm from center to center of fulcrum pin and link pin.
4. Vertical position of driving gear center with relation to center of fulcrum and link pins in rocker arm.
5. Length of rocker arm link.
6. Location of rocker arm link (whether at top or bottom of rocker arm).
7. If link is at top: Distance of ram nut link connection above or below rocker arm link connection. If link is at bottom: Definite location of outer link support.

Calculating Average Cutting Speed

Since the cutting speed on a crank shaper varies at every point of the ram travel, from a dead stop at the very ends to something above the average speed in the middle, it is impossible, or to say the least, impractical, to calculate the cutting speed exactly, but it is entirely possible and practical to determine the average speed for any given length of stroke and number of strokes per minute if the other necessary factors are known.

In making these calculations, it is first necessary to determine what portion of each rotation of the driving gear is used to drive the ram on the forward stroke, what portion drives it on the return stroke, and their relation to each other for the different lengths of stroke to be calculated. This varies with every stroke length. After these proportions are determined, the calculations can be made for whatever length of stroke and number of strokes per minute are desired.

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Since the slightest change in length of stroke changes the cutting speed at any given number of strokes per minute, it is customary, when compiling tables, to calculate the speed at different stroke lengths in increments of 2 inches, such as 2, 4, 6, and 8 inches, and to calculate the relation of cutting time to return time at stroke lengths varying by increments of 4 inches, using for the intermediate stroke lengths the proportion of the length to which they are nearest, either above or below, and if exactly midway that of the one below.

Relation of Cutting to Return Stroke

In determining the relation of cutting stroke to return stroke, there are two types of shapers to be considered, namely, those having the connecting link at the top of the rocker arm, and those having it at the bottom. We will first describe the method for determining the proportion on shapers having the link at the top.

Referring to Fig. 1, the line AB represents the length of the rocker arm and its position in the middle of all stroke lengths, and the point I represents the position of the ram nut link connection in the middle of all strokes. The lines AC, AD, etc., represent the center line AB of the rocker arm at the extreme positions for strokes of various lengths. These positions are determined by laying off on KI from B the points N, M, L, etc., making the distance of each of these points from B equal to one-half the length of a stroke that is to be considered, and then, in turn, laying off from the points N, M, L, etc., the points C, D, E, F, etc., on arc HJ, making LC equal to the length of the link BI, MD equal to BI, NE equal to BI, etc. The line KI is the line of travel of the ram nut link connection, and the arc HJ is the line of travel of the top of the rocker arm, or rocker arm link connection.

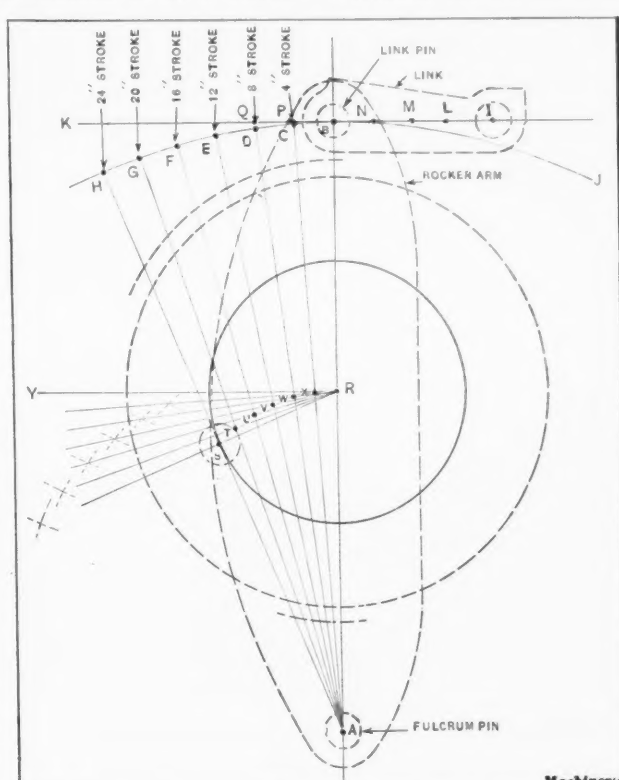

Fig. 1. Diagram used in calculating Cutting Speed of Shaper having Link at Top of Rocker Arm

The point R represents the center of the driving gear, and the next step is to lay off lines from this point that are square or at right angles with the lines AB, AC, AD, etc. The resulting points of

TABLE 1. ARC OF TRAVEL ON FORWARD AND RETURN STROKE OF SHAPER RAM

Stroke in Inches	Arc of Travel				Proportion between Arc of Travel on Cutting and Return Strokes
	Forward Stroke		Return Stroke		
	Degrees	Minutes	Degrees	Minutes	
8	195	10	164	50	1.2 to 1
12	203	20	156	40	1.3 to 1
16	211	0	149	0	1.4 to 1
20	216	30	143	30	1.5 to 1
24	226	0	134	0	1.7 to 1

Machinery

intersection, *S*, *T*, *U*, *V*, etc., are the points at which the driving gear leaves the cutting stroke and enters the return stroke. The points at which the driving gear leaves the return stroke and enters the cutting stroke can also be located in a similar manner on the right-hand side of line *AB*. The amount of arc of driving gear travel above the points *S*, *T*, *U*, *V*, etc., to corresponding points on the opposite side comprise the arcs of the various cutting strokes, and the amounts below comprise the arcs of the return strokes.

The lines *AC*, *AD*, *AE*, etc., represent strokes of 4, 8, 12, 16, 20, and 24 inches, and the lines *RX*, *RW*, etc., form angles with the horizontal *RY* for the various stroke lengths. These angles are measured with a protractor. For a 4-inch stroke, the angle is 3 degrees 45 minutes; 8-inch stroke, 7 degrees 35 minutes; 12-inch stroke, 11 degrees 40 minutes; 16-inch stroke, 15 degrees 30 minutes; 20-inch stroke, 19 degrees 15 minutes; and 24-inch stroke, 23 degrees 0 minutes.

Now the arc of driving gear travel comprising the forward stroke on a 4-inch stroke is 180 degrees plus twice 3 degrees 45 minutes, or 187 degrees 30 minutes, and that comprising the return stroke is 360 degrees less this amount, or 172 degrees 30 minutes. The arcs of travel for other stroke lengths are given in Table 1. To determine the proportion between the cutting and return strokes, it is only necessary to divide the greater by the less. Thus the proportion for the 4-inch stroke is 1.1 to 1. The proportions for other stroke lengths are given in the column at the right-hand side of Table 1.

Shapers with Link at Bottom of Rocker Arm

Next let us take up the method for determining the proportion on shapers having the link at the bottom of the rocker arm. This type represents somewhat different conditions, and the results, although practically the same, are arrived at in a different way. The principal difference, in so far as determining the cutting speed is concerned, is that the rocker arm comes to a different angle at one extreme of its stroke than at the other extreme, as will be seen from the lay-outs in Fig. 2, which represents the forward half of the strokes, and in Fig. 3, which represents the rear half.

As will be seen from these illustrations, the upper end of the rocker arm is connected to the ram nut and travels with the ram in a straight line instead of an arc, the lower end rising and falling through the arc *AW*, and *A'W'*. The lines *AH* and *A'H'* represent the length of the rocker arm and its position in the middle of all stroke lengths. The lines *BI*, *B'I'*, *CJ*, *C'J'*, etc., represent the extreme positions of the rocker arm for various stroke lengths, and these positions are determined by laying off from the points *H*, and *H'*, on the lines *HN*, and *H'N'*, the points *I*, *I'*, *J*, *J'*, etc. The distance from the center *H* or *H'* to any one of these points is equal to one-half the length of the stroke that is to be considered. Using a radius equal to the length of the rocker arm and with the points located on *HN* and *H'N'* as centers, arcs *AW* and *A'W'* are intersected at points *B*, *B'*, *C*, *C'*, etc. The latter intersection points represent the position of the lower end of the rocker arm at the extreme ends of the various strokes.

The points *O* and *O'* represent the center of the driving gear and the next step is to lay off lines from these points that are at right angles with the lines representing the rocker arm, in order to determine the points at which the direction in which the driving force acts is reversed from the forward to the return direction and vice versa. We now find, however, that the resulting angles are somewhat different, owing to the fact that, while the top of the rocker arm moves to extreme points equally distant from the center line, the bottom end moves to and from the same center line, but on one side of it only. This means, further, that while on the other type shaper, to determine the arc of driving gear travel for the forward and return stroke, we added to and subtracted from 180 degrees twice the arc of a certain angle, we now add and subtract the sum of the arcs of two different angles. Referring to Figs. 2 and 3 and using the same dimensions as for the design first dealt with, which is shown in Fig. 1, we find that the resulting angles for a 4-inch stroke are 3 degrees 45 minutes on one side and 4 degrees on the other; for an 8-inch stroke, 7 degrees 45 minutes, and 8 degrees 0 minutes, respectively; for a 12-inch stroke, 11 degrees 45 minutes, and 11 degrees 50 minutes; for a 16-inch stroke, 15 degrees 40 minutes, and 16 degrees 0 minutes; for a 20-inch stroke, 19 degrees 20 minutes, and 20 degrees 10 minutes; and for a 24-inch stroke, 23 degrees 25 minutes, and 25 degrees 0 minutes.

This means then, as before, that the arc of the driving gear travel comprising the forward stroke on a 4-inch stroke is 180 degrees plus the sum of 3 degrees 45 minutes and 4 degrees, or 187 degrees 45 minutes, and the arc of travel comprising the return stroke is 360 degrees less this amount, or 172 degrees 15 minutes. The arcs of travel for other stroke lengths are given in Table 2. It will be noted that the proportions between the arc of travel on the cutting and return strokes are practically the same as found on the other type shaper, although there is actually a slightly greater difference between the cutting and return stroke.

The next step is to make the necessary calculations for each length of stroke and number of strokes per minute to be considered. For example, let us take a stroke length of 16 inches, operating at 30 strokes per minute. Under these conditions, it will be quite plain that the tool in each min-

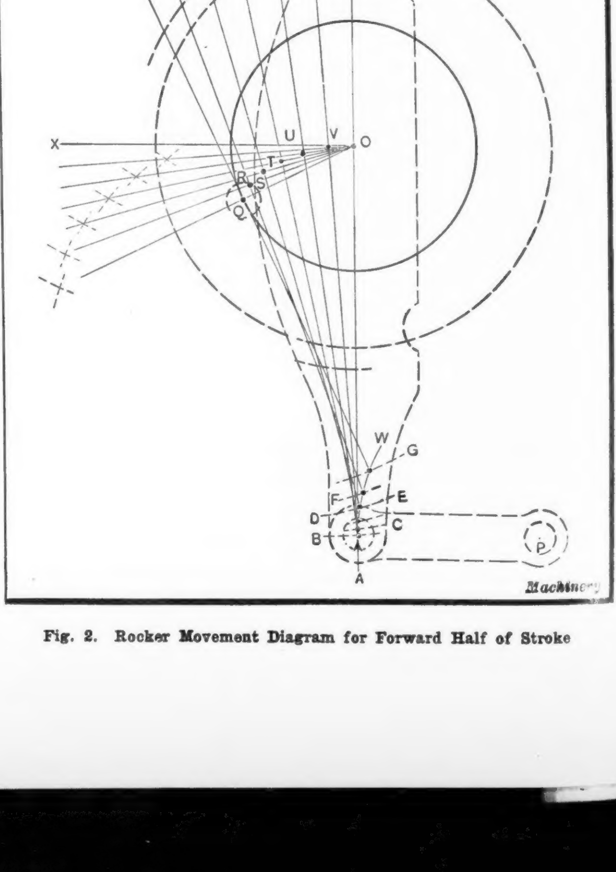

Fig. 2. Rocker Movement Diagram for Forward Half of Stroke

ute, actually moves forward 30 times 16, or 480 inches, but, from the proportions between cutting and return strokes previously calculated, we have found that only a certain portion of the minute is actually occupied in moving forward, the remainder being consumed in returning. Also, since we have found that the proportion between these two time elements, at this stroke length, is as 1.4 is to 1, we see that the time actually occupied in cutting bears the same relation to the entire minute (60 seconds) as does 1.4 to the sum of 1.4 and 1, which is 2.4.

To determine, therefore, the number of seconds of each minute occupied in forward cutting, it is only necessary to divide 60 seconds by 2.4 and multiply the result by 1.4, which gives 35 seconds. This shows that the tool travels forward at an actual rate of 480 inches in 35 seconds, and to determine how many inches of continuous forward travel there would be in 60 seconds, or one minute, we divide 480 by 35 and multiply by 60. This gives us 823 inches as the distance the tool would move forward in one minute if not interrupted by the return strokes. Dividing this figure by 12 (the number of inches in one foot) gives 68 1/2 feet as the average cutting speed in feet per minute for a 16-inch stroke at 30 strokes per minute.

The foregoing calculation may be shortened somewhat as follows: Instead of multiplying by 60, which gives a result in inches per minute, after which we must divide by 12 to get feet per minute, simply multiply by 1/12 of 60 or 5 which gives the result directly in feet per minute. In this particular case it may be even further shortened by simply dividing 480 by 1/5 of 35 or 7, the result being the answer in feet per minute.

For convenience in making the various calculations, the number of seconds in each minute occupied in forward cutting at the various proportions is given in the following: The proportion of 1 to 1 means that 30 seconds are occupied in forward cutting; the proportion of 1.1 to 1, 31 1/2 seconds; 1.2 to 1, 33 seconds; 1.3 to 1, 34 seconds; 1.4 to 1, 35 seconds; 1.5 to 1, 36 seconds; 1.6 to 1, 37 seconds; and 1.7 to 1, 38 seconds.

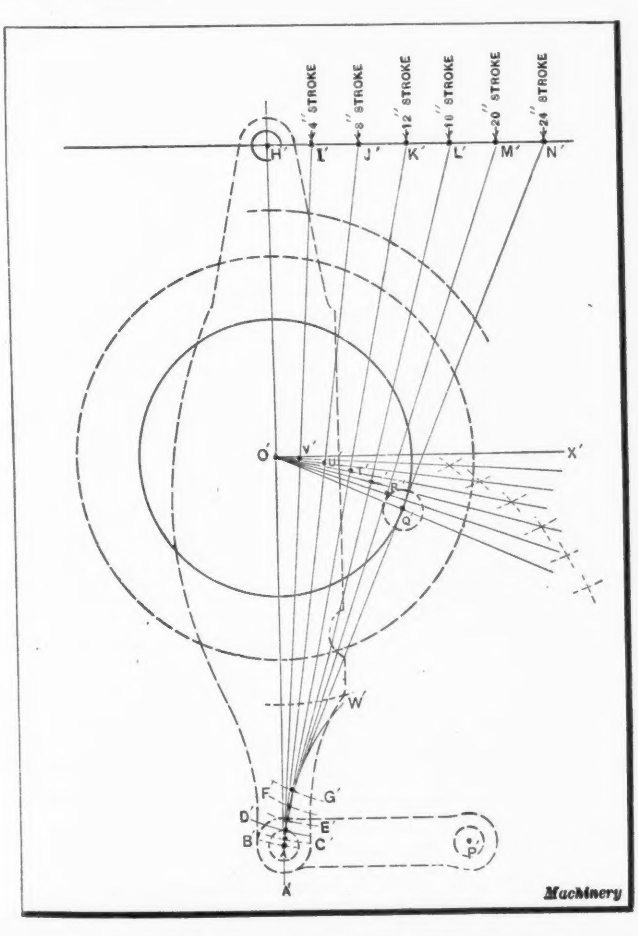

Fig. 3. Rocker Movement Diagram for Rear Half of Stroke

TABLE 2. ARC OF TRAVEL ON SHAPER HAVING LINK AT LOWER END OF ROCKER ARM

Stroke in Inches	Arc of Travel				Proportion between Arc of Travel on Cutting and Return Strokes
	Forward Stroke		Return Stroke		
	Degrees	Minutes	Degrees	Minutes	
8	195	45	164	15	1.2 to 1
12	203	35	156	25	1.3 to 1
16	211	40	148	20	1.4 to 1
20	219	30	140	30	1.6 to 1
24	228	25	131	35	1.7 to 1

Machinery

As stated in an earlier paragraph, the cutting speed varies at every point of the ram travel, being much slower at the extreme ends and somewhat faster in the middle of the stroke. Since this faster speed cannot well be calculated, but in many cases determines the limit of the cutting ability of the tool, it is well to set the actual cutting speed somewhat higher than the average actually calculated. In the previous example in which the calculated average speed is 68 1/2 feet per minute, it is probable that 70 feet per minute would be about the right speed.

Each combination of stroke length and number of strokes per minute must be figured separately, as each gives a different result, but stroke lengths figured at every 2 inches are sufficiently close for all practical purposes. This would mean 96 separate calculations for a 24-inch shaper having 8 speeds, provided that all speeds could be used at all stroke lengths. Upon making the calculations, however, it is found that the slower speeds are of little value on the shorter strokes, speeds of less than 50 or 60 feet per minute being now obsolete on most work.

It is further found in actual practice that speeds of much over 100 feet per minute are impractical, due to the fact that, on the return stroke, the clapper begins to slap at these speeds. As a matter of fact, this is one of the reasons why a greater ratio between the forward and the return stroke than those here given cannot profitably be used, as, by the use of a greater ratio, the cutting speeds would have to be reduced to a speed very much less than that for which modern high-speed tools are designed; it is the speed of the non-productive return stroke that limits the number of strokes per minute, rather than the ability of the tool to stand up under the speed of the forward stroke.

* * *

WHERE THE AUTOMOBILE INDUSTRY LEADS

The automobile industry has a most remarkable arrangement for avoiding the waste of patent litigation. Through the agency of the National Automobile Chamber of Commerce a cross licensing patent agreement is in effect, under which the members grant free licenses to one another. Almost 800 patents have been handled in this way, so that every member of the association is in a position to produce the best possible kind of car, selling it at the lowest cost, without being hampered by prior patents owned by a competitor. There has not been a single patent law suit between members of the National Automobile Chamber of Commerce in the last ten years.

The broad-mindedness of the automobile industry is evidenced in other directions as well. A few months ago the larger manufacturers voted to almost double their own dues to the National Automobile Chamber of Commerce, without increasing the dues of the smaller producers, to the end that the whole industry may be advanced. Each manufacturer gets his share of business on the merits of his product.

In automobile building, 122 standards have been developed, and there is a great deal of cooperation between manufacturers. The engineers of one plant are freely received in other plants, and are shown the methods and processes in use. Often one company assists another in installing some method that has been successful in its own shop.

Automatic Buffing Methods

Third Article of a Series—By CHARLES O. HERB

IN the first two articles of this series, the types of chucks used in buffing small parts on a rotary-head machine, built by the Automatic Buffing Machine Co., Buffalo, N. Y., were described. The present and following articles will deal with the buffing of comparatively large parts, such as automobile headlight reflectors, cooking utensils, pails, etc., on a reciprocating type machine. This machine (which is known as the type H) is equipped with a horizontal rotating spindle, which reciprocates the work back and forth against the buffing wheel. A right-angle attachment is provided for buffing the ends of parts, and a variable-angle attachment for handling taper parts. One particularly interesting application of this machine is the buffing of square, rectangular, and other irregular shaped parts. In operations of this kind, a special mechanism is attached to the spindle. The principles of the machine and a number of chucks that have been developed for use with it are described in this article. The next article will describe the mechanisms employed in handling irregular shaped parts.

Construction of the Machine

The machine is made with two different styles of drive. In one of these, power is derived from an overhead countershaft, connected by means of bevel gears, a knuckle joint, and a shaft to knuckle joint *A*, Fig. 2. From this point the power is delivered through bevel gears *B* and *C* to sleeve *X* which carries gear *F* and is keyed to spindle *E* of the machine. The other drive is by means of a motor mounted on the main head, which drives the shaft of gear *B* through a worm and worm-gear.

Bevel gear *F*, through gear *G* and a short shaft, drives the spur pinion *H*. The teeth of this pinion engage those of gear *J*, the latter having a slot in which may be adjusted a block *K*, which is attached to one end of connecting-rod *L*. The opposite end of this connecting-rod is attached to sleeve *D* by means of cross-head *T*. Collars *S* are attached to spindle *E*, one at each end of sleeve *D*. With this construction, the spindle can be reciprocated with its sleeve an amount depending upon the distance that block *K* is offset from the center of gear *J*. The machines are built with different lengths of stroke, the minimum being 6 inches, and the maximum, 13 inches. If a 5-inch buffing wheel is used in conjunction with a machine having 13-inch stroke, work can be buffed for a length of 18 inches in one operation, and for a length of 36 inches by reversing the work for a second operation.

To facilitate loading, the entire head may be swiveled on base *M*, after handle *N* is manipulated to withdraw plunger *O* from plate *P*. The head is then pulled toward the operator, against a stop, and the chuck reloaded, after which the head is pushed back toward the buffing wheel, plunger *O* automatically entering the bushing in plate *P* when the latter reaches its original position. Thus the machine spindle is always locked in the same position relative to the buffing wheel. It is obvious that this arrangement is a quick-acting one.

The right-angle attachment previously mentioned is mounted on the forward end of sleeve *D*, a bevel gear being mounted on the spindle to drive a similar gear on a shaft of the attachment at right angles to the machine spindle. The work-holding chuck is then mounted on this right-angle shaft. This bracket can be located on the sleeve in such a way as to present the work straight toward the wheel or in an inclined position. For buffing taper parts that are long enough to require the reciprocating motion, the variable-angle attachment is placed on sleeve *D*.

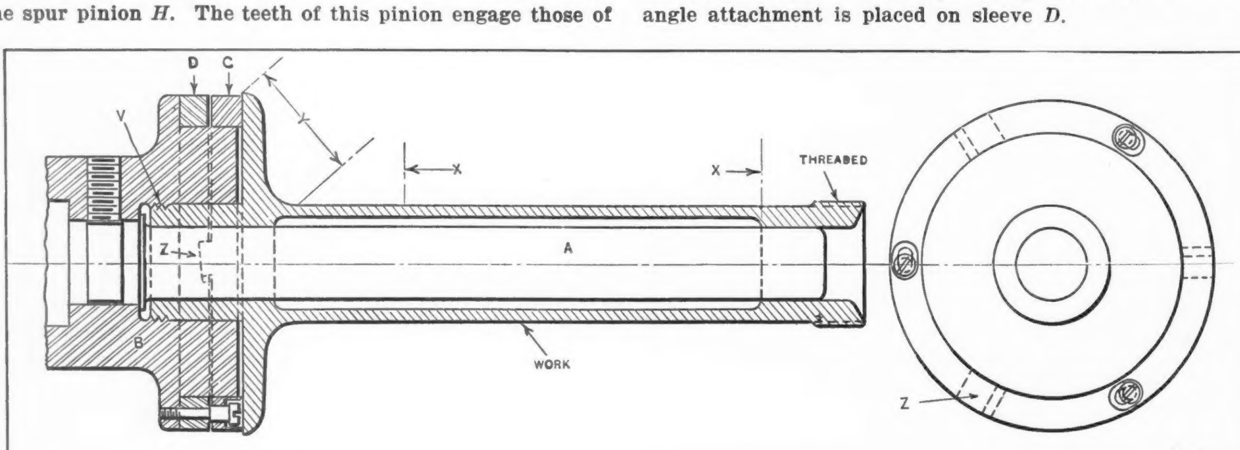

Fig. 1. Brass Casting, which is buffed on a Reciprocating Type of Buffing Machine

There is a transverse adjustment for moving the head to and from the buffing wheel to compensate for wear of the wheel, etc., and there is an adjustment lengthwise of the wheel. These adjustments are obtained by means of carriages on the pedestal of the machine, to which the main head is attached. There is also a vertical adjustment of 4 inches by means of an elevating screw which raises or lowers the work relative to the wheel. In addition, the head may be swung up to 8 degrees in a vertical plane, so as to present the work at an angle to the wheel for buffing across grooves that may have been produced in a previous spinning operation. This angular adjustment is made by loosening nut *Q*. The machine is built in right- and left-hand styles for use at either end of a buffing lathe. The preferable rotating speed of the spindle is 25 revolutions per minute.

Different Methods of Applying the Wheel

Three methods of applying this machine are illustrated diagrammatically in Fig. 3. The operations shown are performed on a reflector for an electric heater, which is about 12 inches in diameter. In the first operation, illustrated at *A*, a left-hand machine equipped with a right-angle attachment is used at the left-hand end of a buffing lathe for buffing the inside of the reflector. The buffing wheel is seated against the bottom of the concave part of the work, and thus buffs the major portion of the surface as the work is revolved.

A side view of the wheel and work in the second operation is shown at *B;* in this case, the wheel is applied tangent to the outside of the same surface, to finish the job. At *C* the main head of the machine is set at an angle for buffing the periphery of the reflector. In this example, the right-angle attachment is dispensed with. The spindle is not reciprocated in any of these operations. On work of the kind just referred to, the production amounts to approximately 55 pieces per hour for two machines, attended by one operator.

Application of the Reciprocating Feature

In Fig. 1 is shown a brass casting, about 9 inches long over all, on which the cylindrical surface is buffed for a length of about 6 1/2 inches in one operation, and the top surface of the flange in a second operation. In the first operation, the wheel is applied as indicated by the dot-and-dash lines *X*, and the work is traversed past it by reciprocating the spindle in the manner previously explained. In the second operation, the wheel is applied as indicated by lines *Y*. The production of two machines per hour is about 120 pieces.

An unusual feature is incorporated in the chuck used for holding this piece. The work is seated on spindle *A*, and a few threads at *V* are screwed into body *B*. Two rings *C* and *D* are seated on a turned portion of the body. At three points *Z*, a slot with a taper bottom is cut into ring *D*, and a corresponding lug on ring *C* engages each slot. When pressure is applied against the work in buffing, ring *C* turns, relative to ring *D*, an amount permitted by the difference in length between the slots and the lugs on the rings.

With this movement the two rings are also separated longitudinally, owing to the wedged surfaces of the slots and lugs. Thus ring *C* is brought to bear against the flange of the work, and exerts a pressure that tends to increase the distance between the flange and threads *V*. In this way, the work is locked securely for the operation, and after it has been buffed, it is released by revolving it slightly in the reverse direction, causing ring *C* to resume its normal position in respect to ring *D*. The work can then be readily unscrewed and removed. Spindle *A* is made of cold-rolled steel, and all the other principal parts, of machine steel.

Work Requiring a Special Holder

There are a number of classes of work that require a holding device in addition to the chuck; such an example is the aluminum tea kettle body shown in Fig. 4. This part is

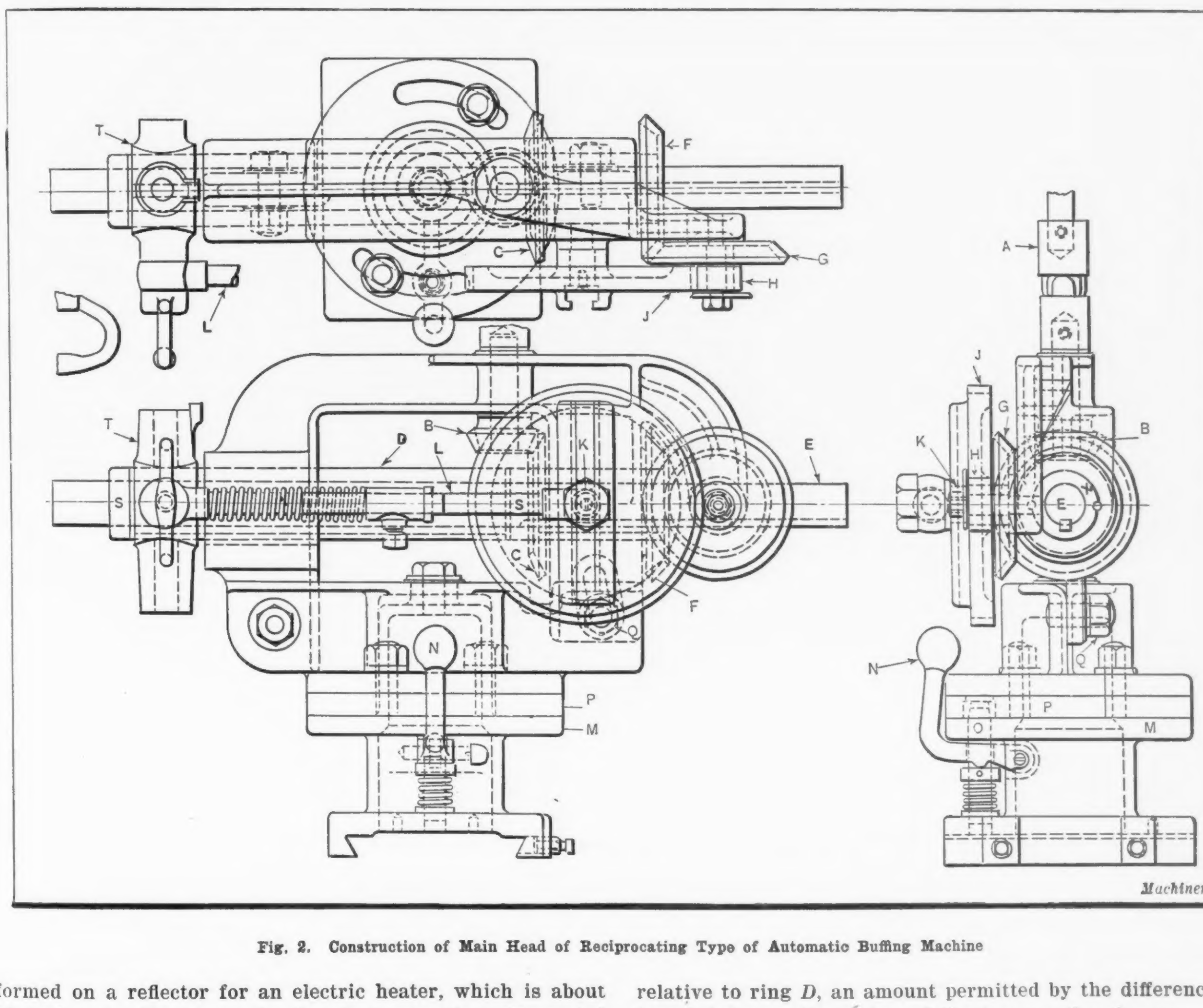

Fig. 2. Construction of Main Head of Reciprocating Type of Automatic Buffing Machine

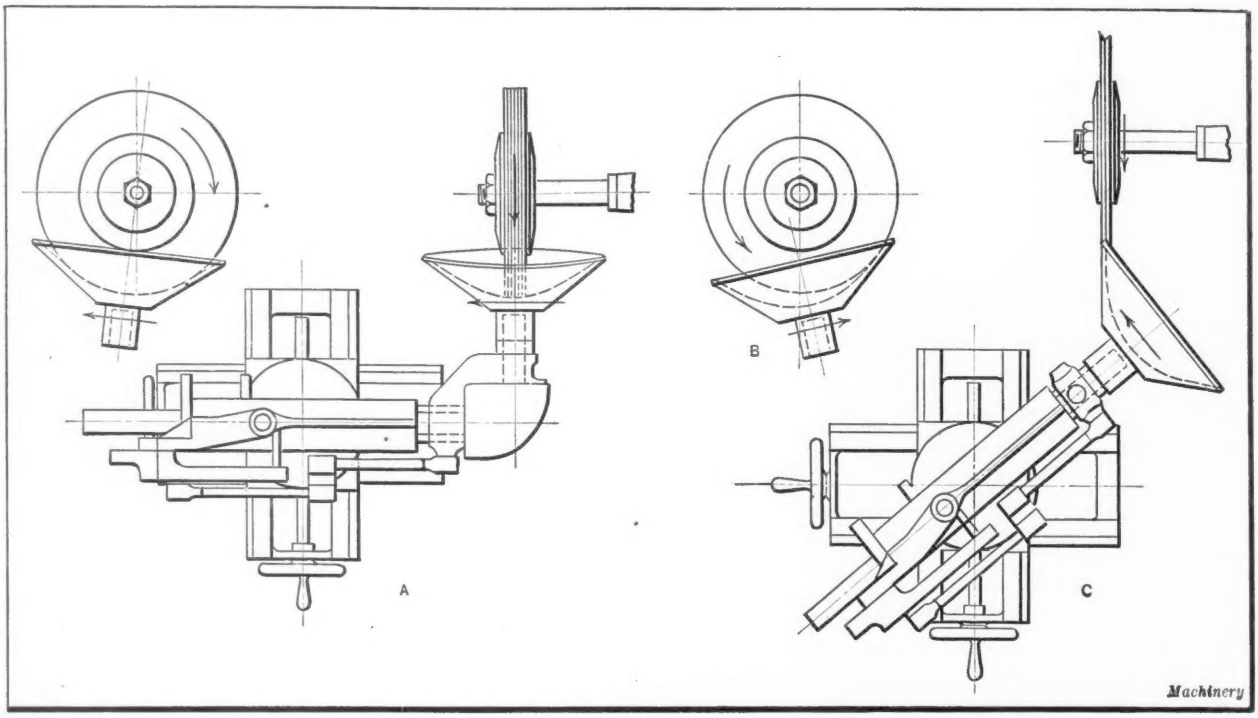

Fig. 3. Buffing the Inside Surface and Periphery of the Reflector for an Electric Heater

about 8 3/8 inches in diameter and 5 1/2 inches wide. The operation consists of buffing the entire rounded contour in two operations, indicated by the dot-and-dash outlines of the wheels. In buffing the straight cylindrical portion, the work is oscillated slightly. This piece could also be buffed in one operation by using a wheel of the same width as the piece, but the former method is better. With two operations, the production averages about 60 parts per hour in each operation.

The work is seated on body *A* by means of the bead, the closed end being kept in contact with the chuck body by a cork-faced aluminum plate *B*, which bears against the depression in this end of the kettle. Plate *B* is attached to a bracket mounted on cross-head *T*, Fig. 2, and can be quickly clamped to hold the part in place, or released for reloading. This type of chuck can be made to suit a large variety of parts by changing the dimensions of body *A* and plate *B*. In many cases, the plate is made of wood and faced with sheet felt or cork to prevent marring the work. In the example illustrated, the cork face of the plate is 1/4 inch thick.

A chuck of much the same design, but intended for a part about 2 inches larger in diameter, is shown in Fig. 5. On account of the work being larger, the body of the chuck *A* is cored and ribbed to reduce the weight. In this case also, the body and plate *B* are made of aluminum. A 1/8-inch sheet of cork is glued to the face of this plate. The production on this part per machine is 40 pieces per hour.

Chucks with Other Means of Locking the Work in Place

The chuck shown in Fig. 6 was designed for holding the base of a desk lamp. This part is about 4 1/2 inches in

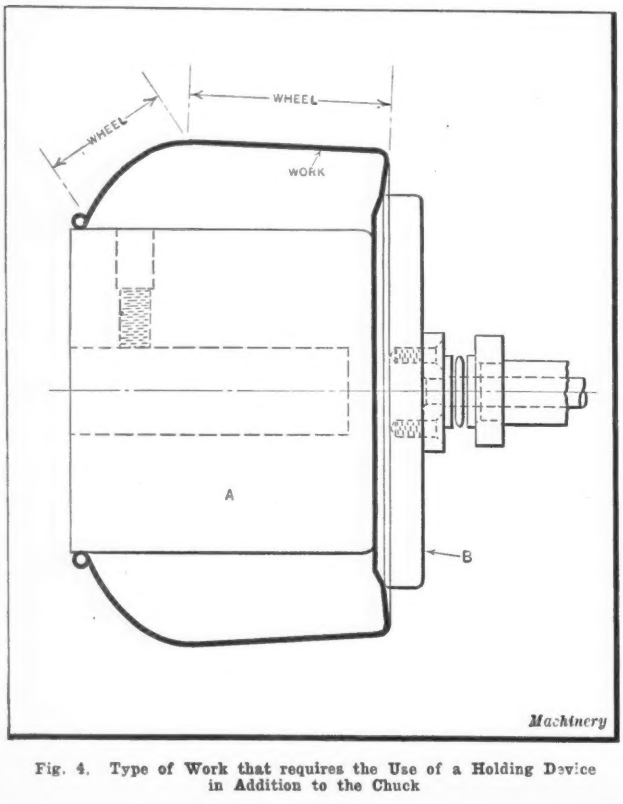

Fig. 4. Type of Work that requires the Use of a Holding Device in Addition to the Chuck

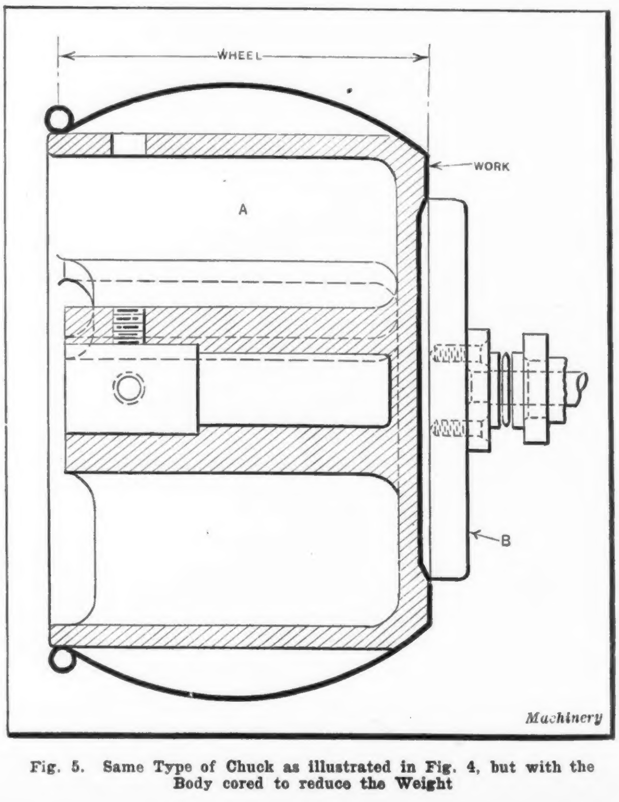

Fig. 5. Same Type of Chuck as illustrated in Fig. 4, but with the Body cored to reduce the Weight

diameter and 3 7/8 inches high. Two operations are performed on the part, as shown by the lines that represent the buffing wheels. In these operations, it is necessary to adequately support the surface being buffed, and for this reason body *A* was shaped to suit the inside of the part. The short hollow section near the bottom of the part is backed up by a cork ring *B*. Screwed into the projecting end of the chuck is a stud *C*, which, with knurled nut *D*, locks the work on the chuck. Nut *D* is counterbored for a short distance into the end nearest the work. On both operations the production per machine is about 180 parts per hour.

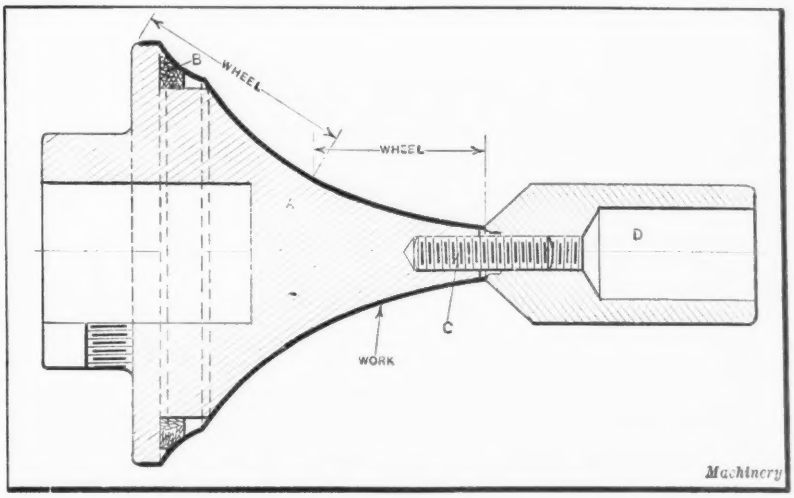

Fig. 6. Construction of Chuck developed for holding a Lamp Base

Fig. 7 shows a chuck developed for holding a steel automobile wheel hub 8 7/8 inches maximum diameter, 7 1/4 inches long, and about 1/4 inch thick over all, while polishing. Three operations are performed on the part, as indicated at *X*, *Y*, and *Z*. The first two operations mentioned are performed by simply revolving the work against the wheel, but in the third operation, the work is oscillated with the main head set at an angle to suit the taper of the part. On each operation the production per hour averages 25 pieces.

The work is well supported by body *A* to which it is locked by means of the knurled handle *B*. Attached to the shank of this handle are two small tool-steel rollers *C*, which engage a bayonet type of slot *D* on each side of the body. The handle is simply slid into place and then given a slight turn to lock it. The flange of handle *B* is chamfered slightly on the face to suit the work.

* * *

GLUING JOINTS

Weakness in glued joints may be caused (1) by allowing the glue to become too cold before applying pressure; (2) by using glue that is too thin and is squeezed out of the joint; or (3) by allowing the glue to dry too much before applying pressure. These three mistakes are the most common ones in gluing practice, and they are known as the "chilled joint," the "starved joint," and the "dried joint," respectively.

Strong joints may be obtained by changing either pressure, assembly time, or temperature, these being the three most important factors in the gluing operation when animal glue is used. Thus a good joint can be made from chilled glue by increasing the pressure, or the glue may be kept from becoming chilled and a good joint obtained if either the assembly time is decreased or the room temperature increased. If the glue is thin, starved joints may be avoided by decreasing the pressure, although such practice is not always recommended. Better average results are obtained if the consistency of a thin glue is increased either by increasing the assembly time or by decreasing the room temperature.

No amount of pressure will produce a good joint from dried glue, but by decreasing either the assembly time or the temperature to which the wood is subjected, a good joint can be made before the glue has dried out. Assembly time, room temperature, and wood temperature are chief among the factors affecting the consistency of an animal glue at the moment pressure is applied. Pressure then must be adjusted to suit the consistency of the glue, the thicker mixture requiring the greater pressure.

The foregoing information on gluing practice is based upon a report of the Forest Products Laboratory, United States Forest Service, Madison, Wis.

* * *

STANDARDIZATION OF DRAFTING-ROOM PRACTICE

The American Engineering Standards Committee has been requested by the American Society of Mechanical Engineers to authorize the organization of a Sectional Committee whose duty it would be to develop standards for drawings and certain drafting-room practices. The society signifies its willingness to act as sponsor or joint sponsor for this project. Drawing is the universal graphical language of the industrial world. It has its "grammar," and uses varied forms of expression, varied styles, all matters of importance on which it is evidently advantageous to have general agreement. As an example of the present-day diversity, not less than 23 different methods exist to represent the most common standard form of screw threads, and this is only one among the innumerable details considered in mechanical drawing.

* * *

AUTOMOBILE PRODUCTION MEETING

An exhibition of machine tools and heat-treating equipment and a convention of automobile production engineers are to be held concurrently in Cleveland, Ohio, September 14 to 16 by the Society of Automotive Engineers and the American Society for Steel Treating. The exhibition is to be held in the Public Auditorium, and 177 exhibits have already been entered. The five technical sessions of the S. A. E. are to be held in the Hotel Winton, while those of the A. S. S. T. are to be held in the Hotel Cleveland. The principal topics to be discussed by the automotive engineers relate to gears, machine tools, sheet steel and its fabrication, inspection, and the training of foremen and mechanics.

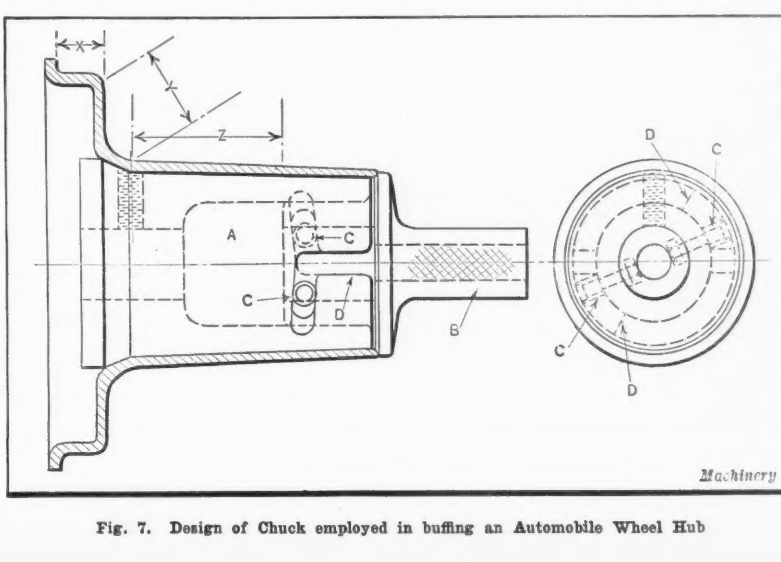

Fig. 7. Design of Chuck employed in buffing an Automobile Wheel Hub

Automatic Coil-winding Machine

By ALBERT A. DOWD

IT is a comparatively easy matter to wind a spring of helical or spiral form, either on an engine lathe, suitably arranged for the purpose, or by automatic machinery. There are no difficult problems involved in such an operation, but in the example *A* shown in Fig. 1 we meet with a number of conditions that are out of the ordinary and require special treatment. The fiber strip *B* is of rectangular shape and is quite long in proportion to its thickness. This strip is to be wrapped with eighty turns of resistance wire from a coil. A machine that will automatically wind the wire and cut it off at the end of each strip is desired.

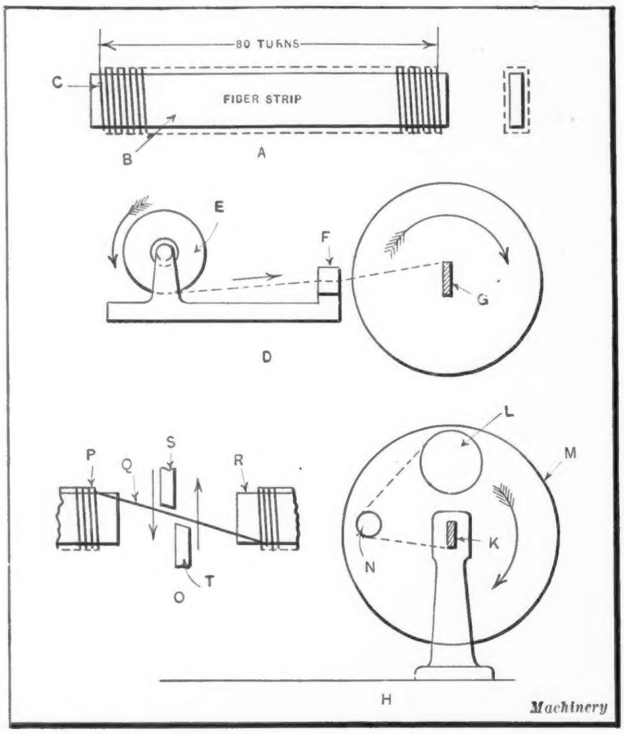

Fig. 1. Diagrams showing Principles involved in designing Coil-winding Machine

As previously made by hand, one end of the wire was inserted in a small hole *C* and bent over to hold it firmly in the fiber strip, which was then revolved in a special chuck, with a suitable support at the outer end, the lathe being geared to give the correct number of turns to the inch. This was a slow process, as it was necessary to stop the machine frequently to insert the pieces and cut the wire. The problem was to provide a continuously operating machine that would not need to be stopped for the insertion of new pieces or for cutting the wire.

In considering the problem, a diagram was drawn up as shown at *D*. In this design, the wire is fed from a reel at *E* through a guide *F*, and wound on the fiber strip *G*, which is held by means of a rectangular chuck and a revolving tailstock center having a rectangular socket. It was evident, however, that it would be difficult to cut the wire off while the piece was revolving, and that the longitudinal movement of the carriage would have to be arranged so that it would feed a certain distance and then return to the original position. Also, the end of the wire that was cut off would have to be picked up and gripped while winding the next strip.

These requirements presented such difficult problems that it was decided to use the method indicated in the diagram at *H*. Here the fiber pieces *K* are fed, one after the other, though a slot at the desired rate of feed, the wire being unwound from a reel *L* on the revolving faceplate *M*. The wire is passed over a guide roll *N* to the strip *K* at a suitable angle for winding. It was decided that the wire could be wound around the pieces and that they could then continue on beyond the point where wound, before separating the pieces by cutting the wire. Then if the foremost piece *P* could be pushed forward more rapidly, as indicated by the diagram at *O*, this piece would stretch the wire out as at *Q*, leaving a space between the fiber pieces *P* and *R* great enough to allow cutters *S* and *T* to clip the wire as required.

General Arrangement of Machine

The general arrangement of the machine is shown by the diagram Fig. 2. The magazine *A* holds the pieces one above the other, and they drop down into a rectangular slot, as shown at *B*. From this point they are pushed forward between the friction rolls *C* and *D* by means of a plunger *E* operated by a cam-drum *F*. The friction rolls carry the piece forward into the feed-rolls *G* and *H*, which are geared

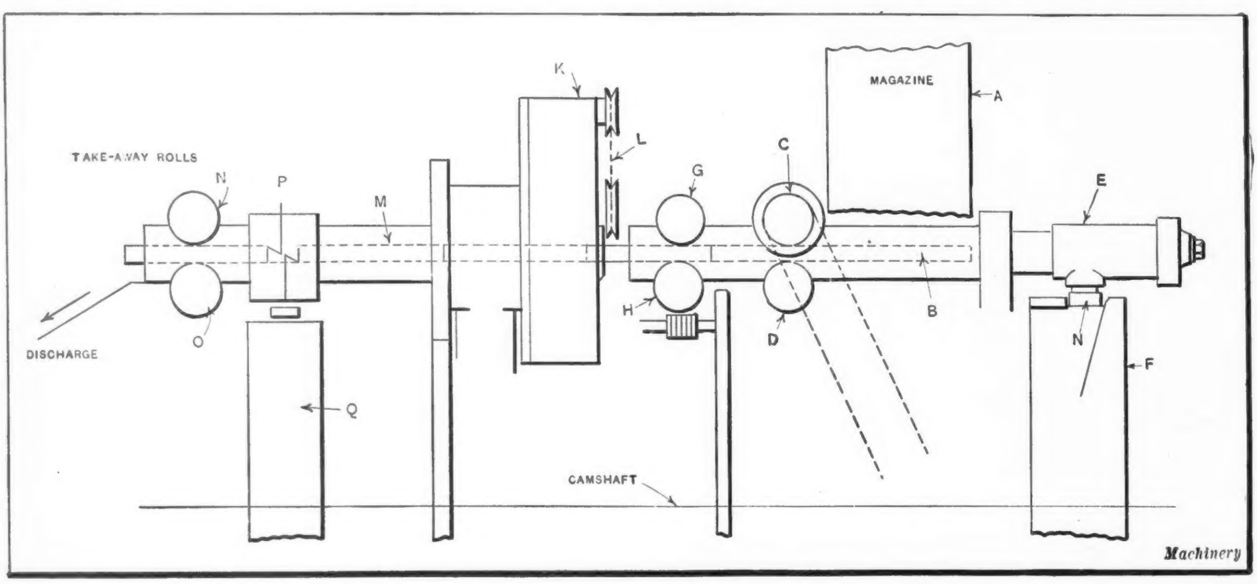

Fig. 2. Diagrammatic Lay-out of Coil-winding Machine

to give the proper ratio between the speed of the revolving member K and the feed. Member K carries a coil of wire, and a strand L of this wire is led over guide rolls, as shown, so that the revolving member K wraps the wire around the fiber strip.

The feed-rolls G and H, acting continuously, push one piece after the other through the hollow sleeve M (which does not revolve), until the first piece comes in contact with the take-away rolls at N and O. The cutting device is located at P, and is operated by a cam-drum Q on the camshaft. This arrangement proved ideal, not only with respect to the sequence of operations, but also as regards the convenience with which the different operating units could be timed to act as required. For example, the main camshaft runs longitudinally along the machine, and all movements are taken from it without difficulty. The two cam-drums at F and Q revolve once for every eighty turns of the spindle.

The main drive is applied through gearing to the spindle carrying the wire coil, and from this it is transferred to the camshaft by worm-gearing. The friction feed-rolls C and D are belt-driven at a speed slightly faster than the actual feed of the pieces through the machine. The feed-rolls G and H are driven by a worm and gear from the camshaft.

Details of the Magazine and Feeding Mechanism

The details of the magazine and fiber strip feeding mechanism are shown clearly in Fig. 3. The upper view at A illustrates the general arrangement of the magazine B and the adjacent mechanism. The pieces are fed downward by gravity into the slot at C in the rigid spindle D. One of the supports of this spindle is shown at E. The end of the plunger D_1 strikes against the fiber strip at C and pushes it forward between the rolls F and G, which are belt-driven.

The sliding sleeve H is actuated by the cams K and L on the drum M. The roll N, attached to the bottom of the sleeve, comes in contact with the cams as indicated. The screw that supports the cam-roll extends into a slot in spindle D, which prevents the sleeve from turning and also limits its longitudinal movement. The enlarged sectional view in the lower left-hand corner of the illustration gives a good idea of the construction of the spindle and bracket at this point. Spindle D has a slot in it at O slightly larger than the fiber piece, and a tongued cap P is secured to the spindle by machine screws, as indicated.

The bracket E is split at Q so that it can be tightened on the spindle by a binder screw. The magazine B is of sheet metal, and rests on the flat portion of the spindle at R, to which it is bolted. This construction permits easy machining of the slot in the spindle. The arrangement of the friction feeding device is shown in the enlarged view at S. It must be remembered that this is not the feeding mechanism that controls the number of turns per inch. The rolls G and F catch the end of the fiber strip as it is pushed forward by the rod D_1, and carry the piece on into the regular feed-rolls.

The bracket T carries both upper and lower rolls, and it is slotted to allow a vertical movement of the bronze pillow-blocks U, for purposes of adjustment. The friction rolls G and F are knurled as indicated, to produce a good gripping action on the fiber strip. The lower roll is aligned by shimming at X, but the upper rolls are held down by two stiff coil springs, as shown.

The upper and lower rolls are geared together, as indicated at Y, and the upper roll is driven through a friction device at Z. This arrangement consists of a pulley A_1, running freely on a bronze bushing B_1. The friction collar C_1 is keyed to the same shaft that holds the roll G, and drives roll G by friction as the face of the collar is pressed against the pulley A_1. A suitable handwheel is provided for adjusting the spring. The bracket T supports the rigid spindle, as well as the feed mechanism, and straddles the spindle D_1; it is tied together at the top by a cap E_1, which gives an exceptionally rigid construction.

Feeding and Winding Mechanism

Fig. 4 shows details of the wire feed mechanism and the mechanism that feeds the fiber strips. The general construction of the bracket B is similar to that just described, the rolls being geared together and mounted in sliding blocks. The lower roll is driven by the worm C through intermediate gearing at D and E, directly from the camshaft. This is a positive drive, giving a regular movement to the fiber strip in the ratio of one strip to every eighty turns of the faceplate H that carries the wire.

In the detailed sectional view at F, the bracket G acts as a headstock for the coil-carrying faceplate H. The latter has a bearing at K in the bracket, and it is driven by the gear L as indicated. In the faceplate is a stud M on which the wire-carrying reel N is supported. From this reel the wire is led across the roll O, and from there between other rolls at P, Q, and R, roll R being grooved and set so that it will lead the wire between the two slightly separated and chamfered ends of the rigid spindles S and T. These are set only a short distance apart so that they also tend to prevent the wire from running to one side or the other in feeding.

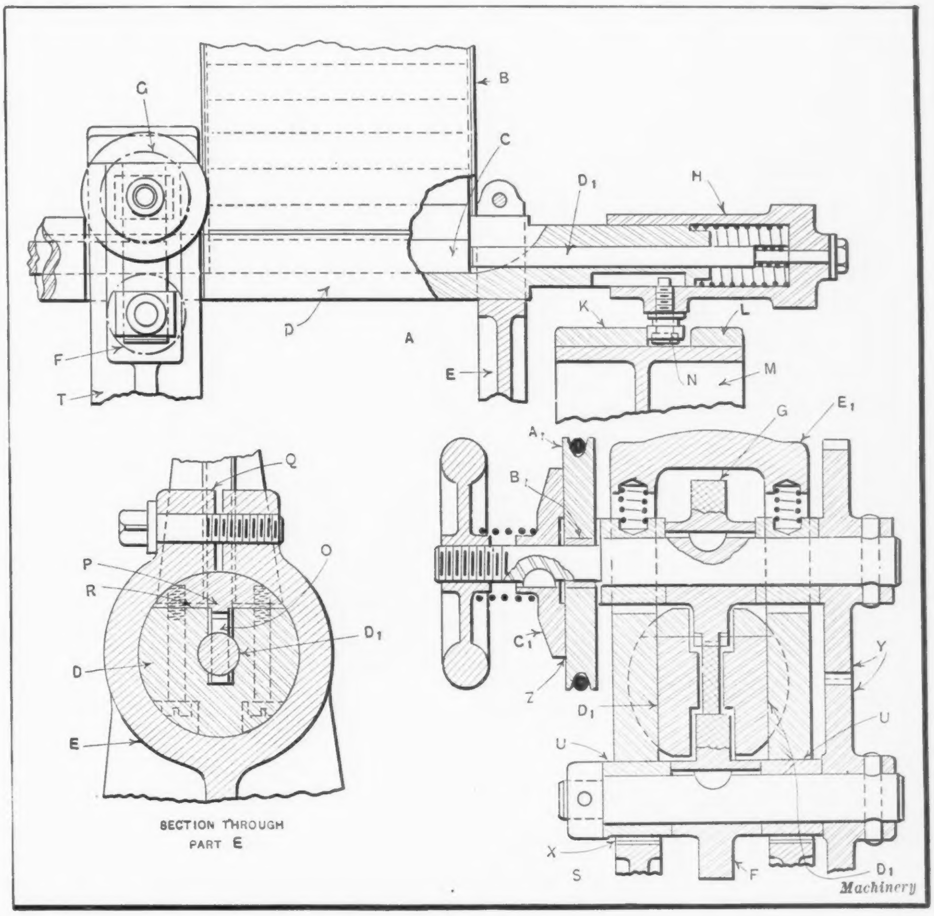

Fig. 3. Details of Fiber Strip-feeding Mechanism

The roll P is set on an eccentric stud, which can be adjusted slightly to produce the required tension on the wire. An arm U is pivoted to the faceplate as shown, and has a friction face at V which is kept pressed against the wire on the coil by the action of the coil spring W. This arm has a width slightly narrower than the distance between the sides of the wire drum so that it also prevents the drum from being moved out of position by the varying pull of the wire from one side to the other as it unwinds.

A counterweight X is bolted to the faceplate opposite the coiled wire, and although the latter diminishes in weight continually, the speed of the spindle is not great enough to cause any trouble from imperfect balancing. The weights Z are of disk shape, and weigh slightly less than a full coil of wire. It was not possible to obtain a compensating device of an automatic form that would take care of the variations in weight exactly, but this answers the purpose very well, and no trouble was experienced with it.

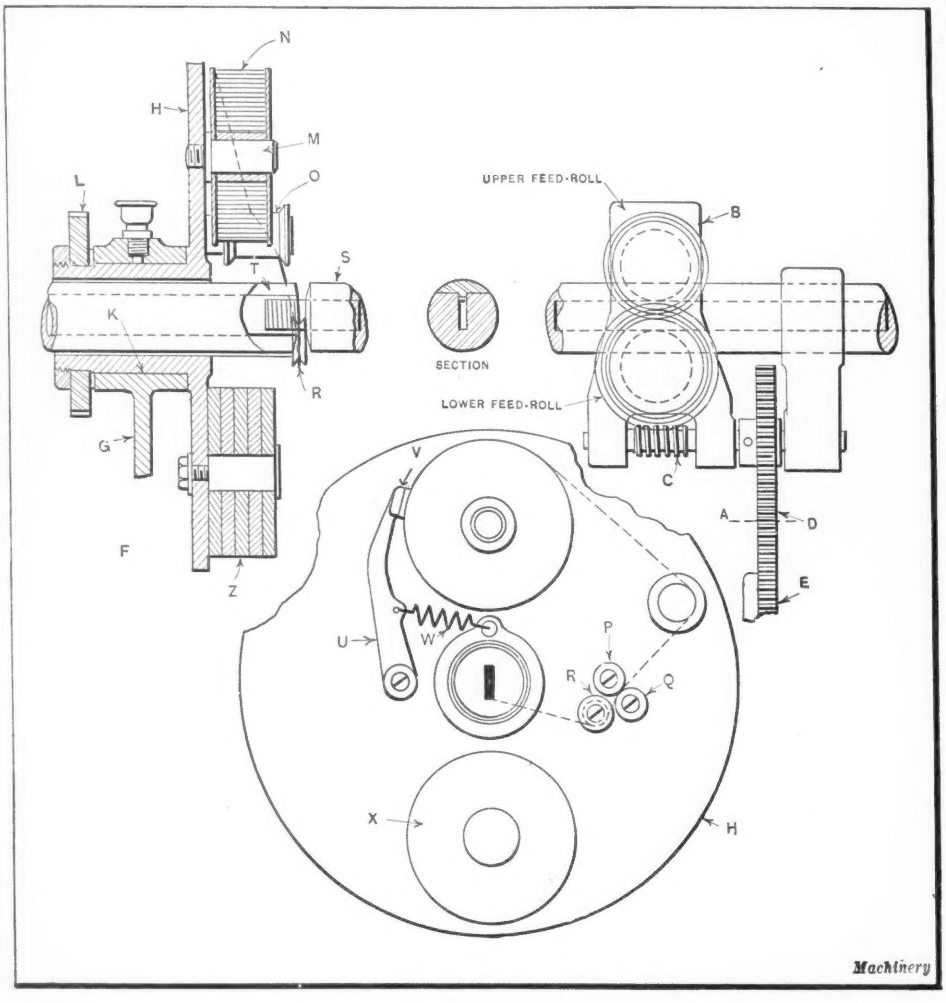

Fig. 4. Details of Wire-feeding Mechanism

Wire Cutting-off Mechanism

If we refer again to the diagram shown at O in Fig. 1, it will be evident that after the pieces have been wound, they must be made to pass through the rigid spindle and into the take-away rolls, which pull the foremost strip along faster than those following, thus stretching the wire out to the form indicated. While in this position, the wire is cut quickly, allowing the first piece to drop into the discharge chute. The take-away rolls are exactly like the feed-rolls except that they are driven considerably faster. As soon as the piece passes between these rolls and separates itself from the one following, the cut-off mechanism must come into action.

Fig. 5 shows two views of the details of this mechanism; A is a plan view, and B is a partial section. A section of the take-away rolls is shown at C, but no details are necessary, as they are the same as the feed-rolls except for the gearing. The entire cutting-off mechanism is mounted on the rigid spindle D by means of suitable screws. The double bracket E has a cylindrical plunger F on each side of the central spindle. At the end of the plunger is a cutter G, inserted in a slot and fastened by screws. The two cutters are arranged as shown in the plan view by the dotted lines, and they are far enough apart, when withdrawn, to allow plenty of room for the fiber strip H to pass between them.

The end of the plunger K passes through a bushing as shown, and enters the upper part of the arm L. This arm is attached to a shaft M below the spindle, and the inner end is connected by means of a link N to the double-end lever O. The small end of the latter has a roller at P which engages a cam Q on the cam-drum R. As the latter revolves, lever O is pushed out of position by cam Q, thus pulling in rod M, which causes the movement to be transferred to the plungers F and cutters at G. This movement takes place rapidly, cutting off the wire between the two pieces as it is stretched out, so that the cutters recede quickly enough to prevent interference with the following piece.

The slot in the spindle is made large enough so that the additional wire does not cause trouble, but passes through freely. It may be mentioned here that the wire itself is not of a springy nature, and remains where it is wound without trouble. If spring wire were used, the ends of the wire would probably catch and cause considerable trouble. There was a tendency for the take-away rolls to stretch out a few turns of wire near the end of the piece, but this was not important, as they were easily slipped back into position by hand.

The machine described offers a good example of progressive automatic machine design. Attention is called to the substantial form of the various working units, their general features of construction, and particularly the ease with which they can be assembled, adjusted, and the parts replaced when worn or broken. The method of driving various units from the camshaft is also of importance. The unit form of construction allows all important fitting to be done before the final assembling, which is, of course, an important factor in lowering the manufacturing costs.

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AVOID CARELESSNESS IN MAILING

The Post Office Department calls attention to the fact that 21,000,000 letters go to the Dead Letter Office every year, in addition to 803,000 parcels. Last year the misdirected envelopes contained $55,000 in cash, $12,000 in postage stamps, and $3,000,000 in checks, drafts, and money orders that never reached the persons for which they were intended. All this could have been avoided if each letter and parcel carried a return address, and if all parcels were wrapped in heavy paper and tied with strong cord. The most astonishing statement made is that about 100,000 letters are mailed annually in perfectly blank unaddressed envelopes.

PREVENTING ACCIDENTS

In an article by Luther D. Burlingame of the Brown & Sharpe Mfg. Co., Providence, R. I., entitled "Preventing the 'Unpreventable' Accident" published in a recent number of the *National Safety News*, the author mentions an incident that illustrates how steps may be taken to partially, at least, prevent so-called "unavoidable" accidents. The superintendent of a large plant was asked to look over a list of some forty accidents that had recently occurred, with the idea of making suggestions for reducing such accidents. In looking the list over, item by item, he pronounced them, one after another, "unavoidable," at least on the part of the management, charging many of them to the carelessness of the workmen.

Among the accidents included were "slipping and falling down stairs." Non-slip treads and hand rails were later provided. "Cut by broken glass in the door." Steps were taken to see that such broken glass was promptly repaired, wire glass being used. "Fell over handle of truck." Well defined aisles were provided with directions to keep them clear of obstructions. Truck handles were painted white, so that they could be more readily seen. Through means like these, the number of accidents was reduced by more than one-half, all by active safety measures on the part of the management. This case is typical, and is illustrative of the saying "The man who says 'it can't be done' is interrupted by the man who is doing it."

In the same article the author points out that in the use of chains there has been much discussion as to the advantage of annealing at intervals. While this is still a debatable question, it has been found that, in some cases, more harm than good has resulted from annealing. The practice that has been satisfactorily followed in the foundry of the Brown & Sharpe Mfg. Co., is to test chains as follows: New chains are prick-punched at three-foot intervals, and a gage provided by which the stretch of the chain is tested from time to time. When this stretch amounts to one-third of a link or more in this length, the chain is repaired or rejected. Foundry chains are inspected every six weeks.

Bulletin boards are recommended, on which are posted monthly reports in regard to accidents in different departments of the shop. This develops a competitive spirit between the different departments. When such a spirit develops, there is a mixed feeling of sympathy and resentment when a workman is injured—sympathy with him for his injury, and resentment that his or some fellow workman's carelessness has lowered the standing of the department. In a factory where the foreman is held strictly responsible for the safety conditions of his department, these mixed feelings on his part are also in evidence. This brings to mind the story of the workman, whose first thought after falling into an elevator shaft and coming to his senses, was: "Is the boss mad?"

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CONFERENCE ON EMPLOYE REPRESENTATION

The Production Executives' Division of the American Management Association, 20 Vesey St., New York City, will hold a conference on "Employe Representation" at Kansas City, Mo., November 30 and December 1. Cyrus McCormick, Jr., vice-president and works manager of the International Harvester Co., is announced as one of the speakers at a dinner to be held Monday evening, November 30.

ENGINES WITH RADIAL CYLINDERS

Attention is called in the *Automobile Engineer* to the fact that certain difficulties experienced with the rotary engine having radially arranged cylinders disappear in the static radial type, and it is possible to build this in considerably higher powers. Engines of 400 horsepower are in regular production, and serious proposals have been made for units of twice that power, in the design and the construction of which no insuperable difficulty should be encountered. Static air-cooled radial engines may be run continuously at piston speeds exceeding 2000 feet per minute, and at brake mean effective pressures of more than 120 pounds per square inch at normal speed, the weight per brake horsepower being considerably less than 2 pounds. In this class of engine, the practical limit in size and speed is set by the loading and the rubbing speed of the big-end bearing. Attempts to use ball or roller bearings on the crankpins of large radial engines have been attended by great difficulties and many failures, owing to the destruction of the bearings by the high combined centrifugal and shock loadings. Plain big-end bearings enable the dimensions and the weight of the master connecting-rod to be kept within reasonable limits, and therefore the number of revolutions to be increased, but the design of a split big-end to take a number of articulated rods is by no means a simple matter.

Unlike the rotary engine, which is carried by its crankshaft through the medium of the ball or roller bearings, the static radial engine may be mounted by its crankcase directly upon the end of the fuselage or upon a special fixed or hinged mounting plate. This makes a much simpler mounting than is required for the line or V engine, and facilitates the replacement of the engine. The single-throw crankshaft, and in less measure the double-throw crankshaft of twin-row radial engines, is short and stiff, and torsional vibrations are not troublesome, while it is possible to effect very good balance by simple weights on the crank webs.

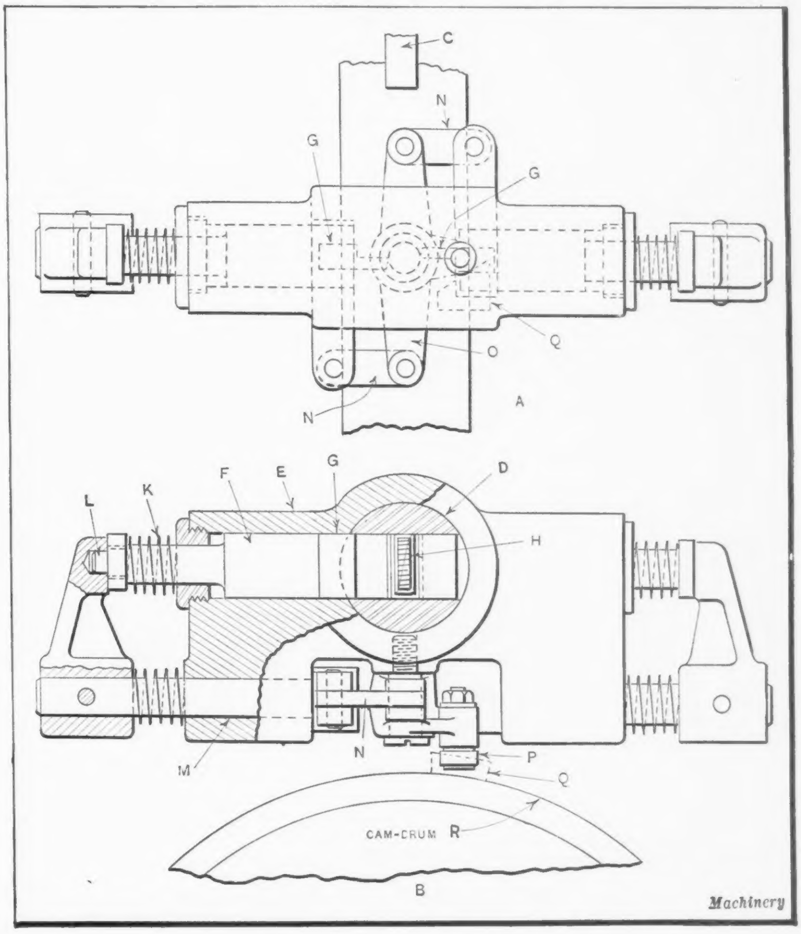
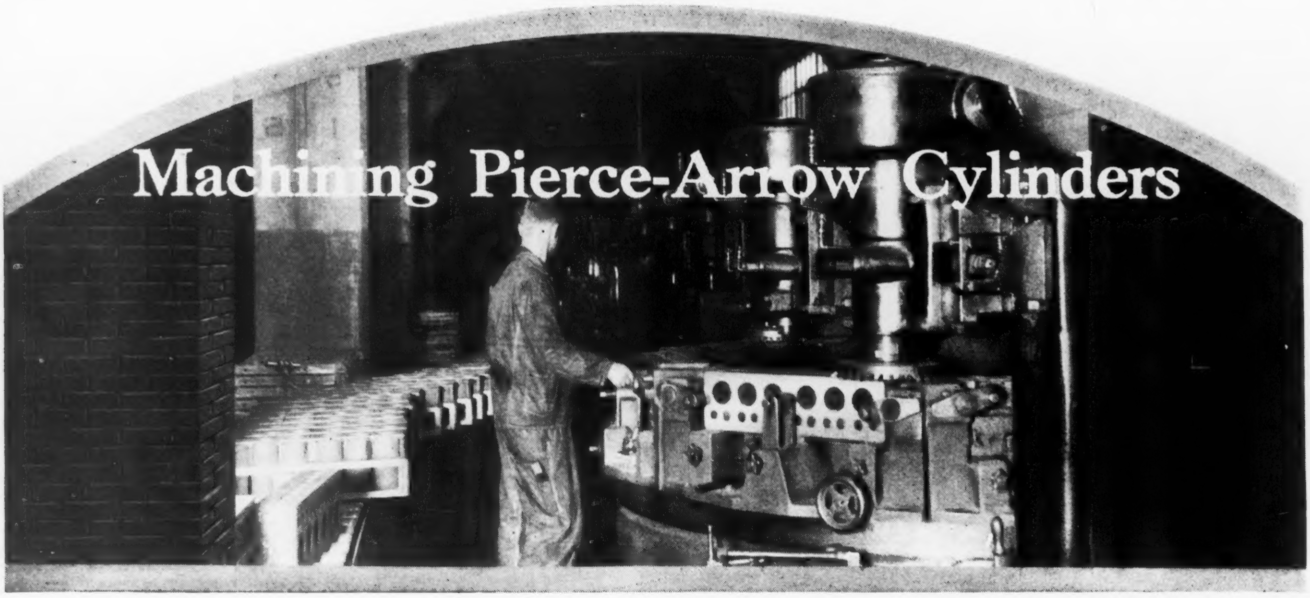


Fig. 5. Wire Cutting-off Mechanism

Machining Pierce-Arrow Cylinders



Fixtures Used in Milling Cylinder Blocks and Reaming the Valve-stem Holes and Seats

By CHARLES B. EKDAHL, Chief Tool Engineer, Pierce-Arrow Motor Car Co., Buffalo, N. Y.

WHEN an automobile company decides to build a new car model which will necessitate regrouping machines and redesigning tooling for the manufacture of certain parts, the engineering department has an excellent opportunity to make use of ideas obtained through past experience. A number of improved methods were introduced at the plant of the Pierce-Arrow Motor Car Co., Buffalo, N. Y., when production was started on the six-cylinder series 80 automobile. Some of the ideas carried out will be described in this and a later article.

Past experience in the machining of cylinder blocks had shown that it was a cumbersome method to place the cylinder in a jig that is pushed on a track from machine to machine and then emptied at the end of the machine group and returned to the starting position. With that method, tie-ups of the jigs are frequent, because of one or two machines in a group being slower than the others. There are also other disadvantages, as, for instance, the extra floor space required for returning the empty jigs to the first machine. So a new method of handling the work was adopted. Now each machine in the cylinder line is equipped with a jig attached to the table, and a simple gravity conveyor, such as seen in the heading illustration, has been installed for carrying the cylinders from machine to machine. One man operates from one to three machines, and if a quantity of cylinder blocks becomes tied up, more men can be readily added to speed up production at the congested points.

Milling Operations on the Cylinder Blocks

The first operation in the cylinder department consists of rough- and finish-milling all four sides of the cylinder block in a Newton continuous vertical machine, as shown in the heading illustration. This machine is equipped with a roughing and a finishing cutter on each side, as illustrated diagrammatically in Fig. 1, the roughing cutters being indicated by *X* and the finishing cutters by *Y*. This machine is tended by two men, one at the front or "loading and unloading" side, and the other at the rear or "rearranging" side.

Fixtures of two types are placed alternately around the machine table, there being eight fixtures in all. The operator puts the rough casting in one fixture for rough- and finish-milling the top as it is carried past the two face milling cutters on the left-hand side. About 0.005 inch of stock is left on the top for grinding. At the rear of the machine, the operator turns the cylinder over in the same fixture, so that the bottom is rough- and finish-milled as it is carried past the cutters on the right-hand side of the machine.

When the casting again reaches the first operator, he places it in the second type of fixture, with the port side up, and this side is rough- and finish-milled as the casting is carried to the rear, by the same cutters that finished the top side. The second operator then turns the cylinder over in the same fixture, and the plate side is machined under the two right-hand cutters as the cylinder is again carried to the front.

In Fig. 1 the cylinder blocks with the top side up are indicated by the letter *A*, those with the bottom side up by *B*; those with the port side up by *C*; and those with the plate side up by *D*. The cutters on the left-hand side are 3/8 inch higher than those on the right-hand side, because when the castings reach the right-hand side they are approximately that amount lower, due to the stock removed. As there are eight fixtures on the table and each cylinder must pass twice around the machine, it is obvious that four cylinders are completed at each revolution of the table. All milling of the cylinder is thus completed when the operator places it on the gravity conveyor to be carried to the next machine.

Charles B. Ekdahl

Details of the Milling Fixtures

Figs. 2 and 3 show the details of the fixture in which the cylinder is held for milling the top and bottom. When the top is milled, there are no accurate machined surfaces from whch to locate the block. It is located approximately for height by two plugs *A* which enter two port holes, and is then clamped against two plates *B* and plug *C* which is raised by means of lever *K* after the cylinder is placed in the fixture. The clamping is accomplished by swinging arm *G* and two clamps *H* into place, and then tightening their screws against the casting. Spring-actuated pins *I* in the three hardened steel plates *L* contact with the bottom of the cylinder.

The top of the cylinder is brought to the correct milling position by adjusting screw D, which is held in a set location, and is used only to compensate for variations in the castings. The inner end of this screw bears against a wing on the eccentric bushing E in which plug C is contained. By turning screw D, bushing E is revolved slightly, and plug C is moved to the front or to the rear. A spring-actuated plunger bears against the rear side of the wing on bushing E so as to keep it in contact with the adjusting screw. After adjusting a cylinder block into the desired position, the screws of clamps G and H are permanently tightened against the front of the cylinder, clamps F against two port holes, and screws J to lock pins I in place. The cylinder is now firmly held for the first milling step. The construction of pins I will be described more fully later.

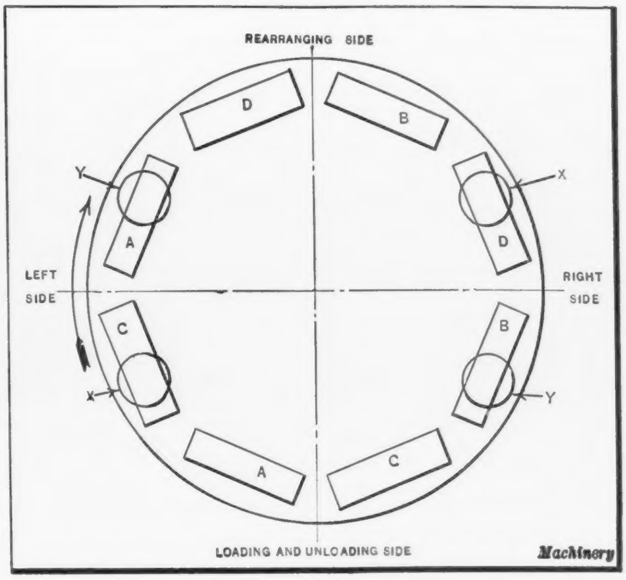


Fig. 1. Diagram showing the Setting of the Work in the Different Fixtures when the Table is completely loaded

When the fixture reaches the other side of the machine, the cylinder is removed so that the fixture may be thoroughly cleaned, plug C being first lowered beneath plate L to guard against damage to it. The cylinder is then replaced, with the finished top resting on plates L, and firmly held by tightening three clamps O on a ledge at the back, and two clamps M in port holes at the front. Probably the most interesting features of this fixture are the methods of operating eccentric bushing E and clamps M. These clamps are swung by hand into the port holes, and then pulled down on the wall of the holes by tightening nuts N. As each nut is tightened, it pulls down on a bar P to which the clamp is attached, and thus also pulls down the clamp.

The second type of fixture used in this machine is illustrated in Figs. 4 and 5. The cylinder is placed in this fixture at the front of the machine, with the bottom side against the three hardened plates A, and with the recess on the plate side resting on two plugs B, the remainder of the plate side being supported by three pins E. The cylinder is then clamped against plates A by swinging arm C and clamps G into place and tightening the screws. It is clamped in two rough cylinder holes by means of the two bellcrank clamps D which are swung down on the work by tightening bolts M. These bolts bear against the lower end of the clamps, causing them to swivel, as shown in the sectional view in Fig. 5.

The three spring pins E in plates K are next tightened by means of screws F, to support the under side of the work firmly against the thrust of the cutters. The inner end of each screw is wedge-shaped, as is also shown in the sectional view, and engages a similar wedge surface on the pin, to prevent the pin from sliding down under the cut. The construction of pins I and screws J in Figs. 2 and 3 is similar to this.

Another important mechanism is that employed for raising and lowering plugs B, it being desirable to have these

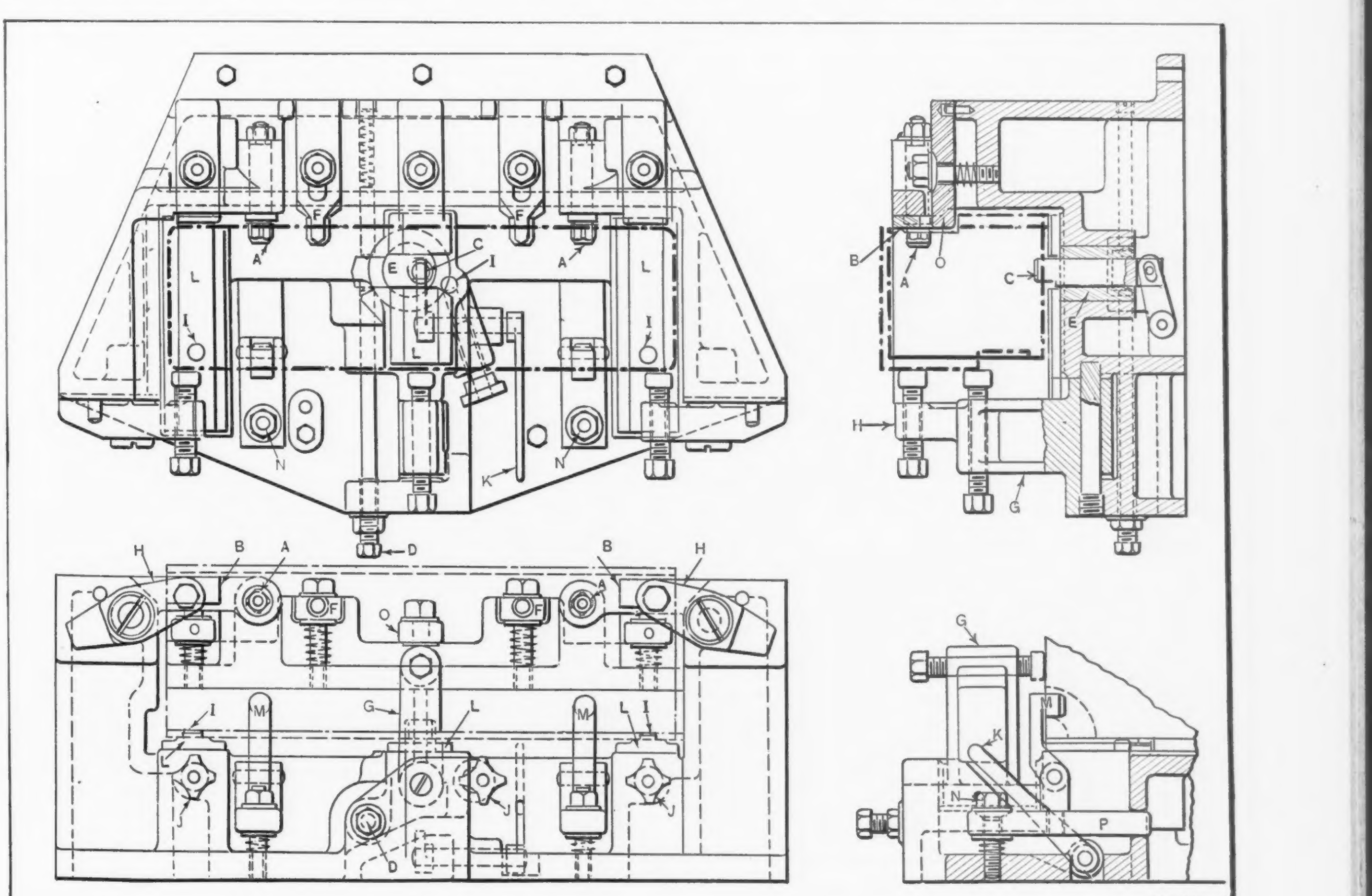


Fig. 2. Details of Fixture used in milling the Top and Bottom Sides of the Cylinder Block

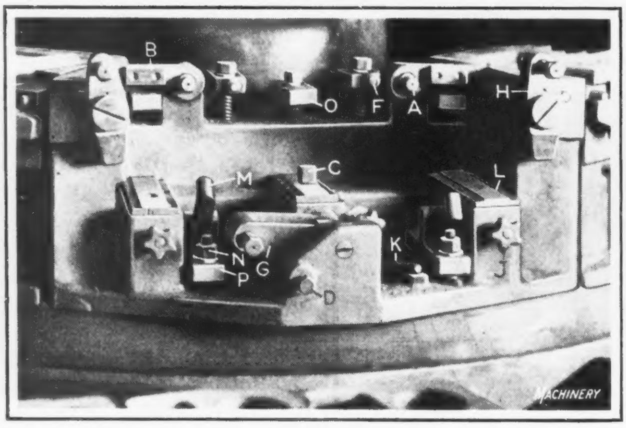


Fig. 3. Fixture shown in Fig. 2, for milling the Top and Bottom Sides of the Cylinder Block

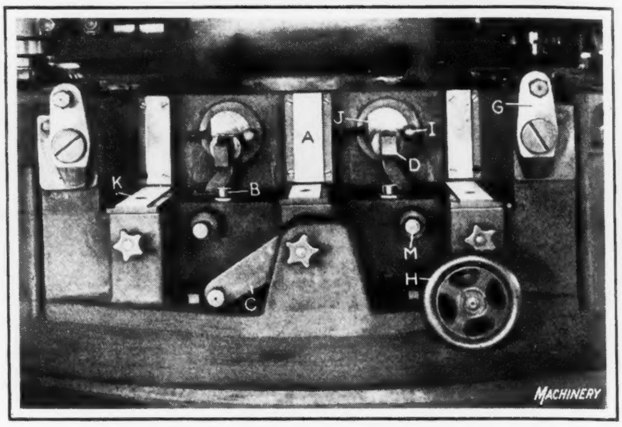


Fig. 4. Fixture employed in milling the Port and Plate Sides of the Cylinder Block

pins lowered beneath the surface of plates *K* when placing a cylinder into or taking it out of the fixture. The plugs are raised or lowered by turning handwheel *H*, which is mounted at the front end of a shaft having gear teeth cut on the opposite end at *N*. These teeth engage a rack on the right-hand end of the long bar *L*, so that this bar can be slid to the right or left by simply turning the handwheel. When the bar is slid to the left, wedge-shaped surfaces *O* raise plugs *B* by coming in contact with their lower end. Then when the bar is returned to the right, coil springs surrounding the plugs draw them again beneath plates *K*. Thus it will be seen that both pins can be quickly raised or lowered by a simple motion of the handwheel.

When the second fixture reaches the rear of the machine, the cylinder is removed and the fixture cleaned, after which the cylinder is replaced with the plate side up and the top side against plates *A*. In this set-up, clamps *D* bear in two rough cylinder holes, but as these holes are higher than the surface on which the clamps were tightened in the preceding set-up, it is necessary to provide a means of raising the clamps to suit. This is accomplished by attaching each clamp to a shank that extends back into an eccentric bushing *J*, and by indexing this bushing to raise the clamp. Each bushing may be located in the two positions by means of index-pins *I*. The sectional view in Fig. 5 indicates the high position of the clamps by dotted lines. Pins *B* and *E* are kept lowered in this step, the cylinder resting on plates *K* and being held firmly by clamps *C*, *D*, and *G*.

Other Operations on the Cylinder Blocks

From the continuous milling machine, the cylinder blocks are carried by the conveyor past a battery of upright drill-

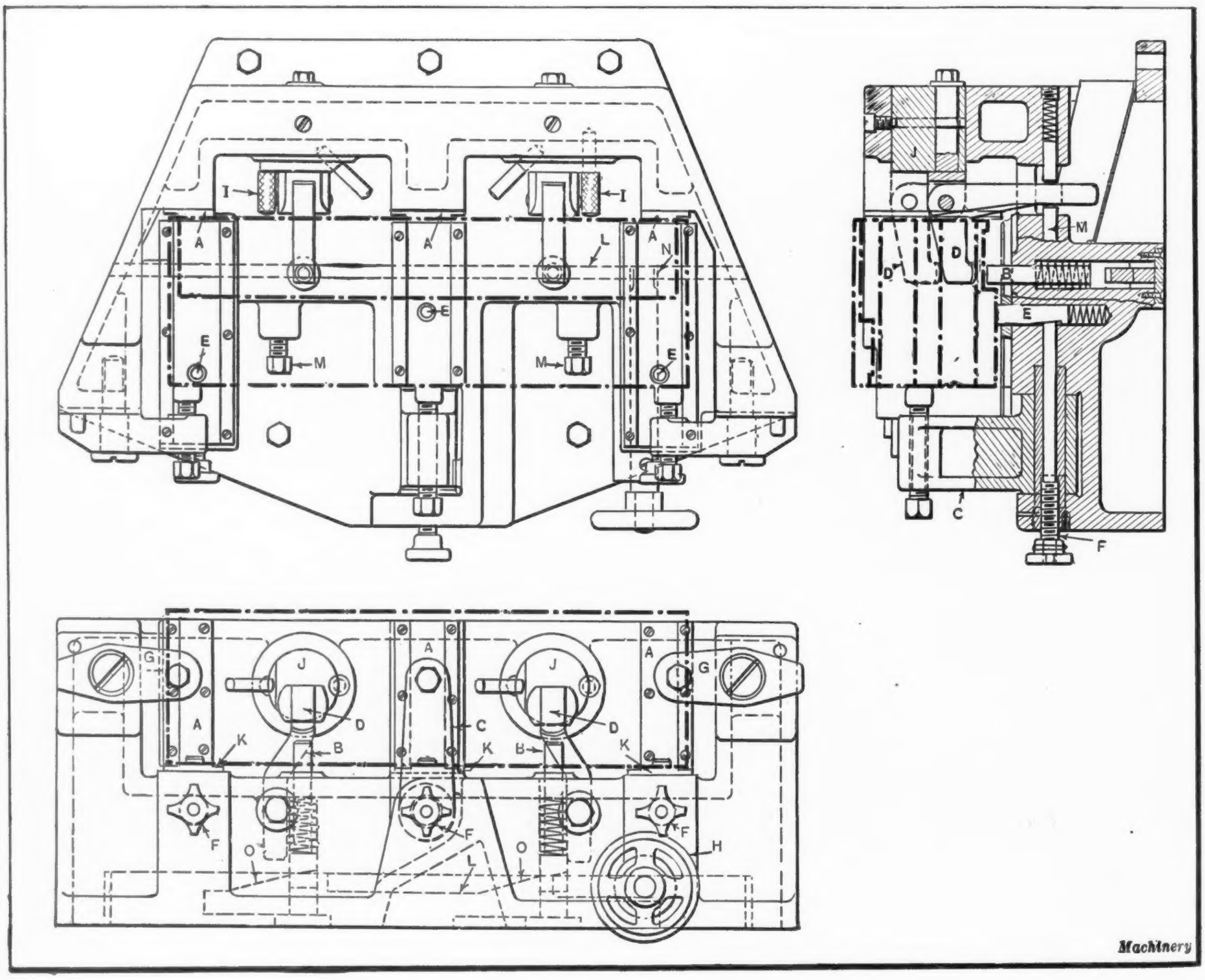


Fig. 5. Construction Details of the Milling Fixture shown in Fig. 4

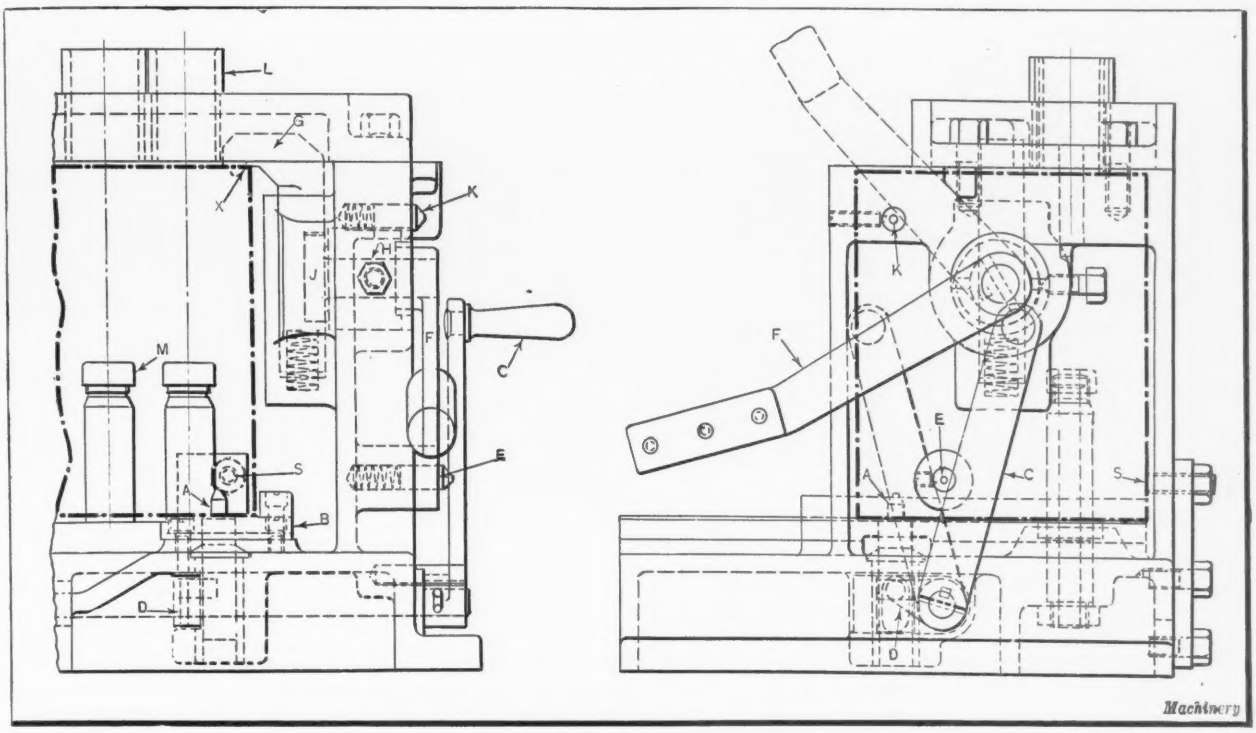


Fig. 6. Details of Construction of the Jig shown in Fig. 7

ing machines on which various drilling, reaming, boring and tapping operations are performed. In order to reduce tooling costs to the minimum, the jigs for these machines were made as nearly alike as possible, five of them being practically the same, with the exception of the bushing plates, etc. The bases of the five jigs are made from the same pattern. The jig used for reaming twelve valve guide holes and openings in the top of the cylinder block is shown in Figs. 6 and 7.

In placing the work in this jig, two dowel-pins *A* are lowered so that the cylinder can be slid on two hardened steel plates against two studs *S*, which are located approximately. Accurate location is then obtained by raising handle *C* on the right-hand side, which raises both dowels *A* into previously reamed stud holes in the bottom of the cylinder. Handle *C* is mounted on a shaft which extends along the jig and has two arms *D*, each of which carries a plug that engages a hole in the lower end of the corresponding dowel *A* to raise or lower it, depending upon the direction in which the handle is turned. Spring plunger *E* holds the handle in the raised position. If the dowels were not lowered before unloading the jig, they would soon become damaged from dropping the heavy cylinder on plates *B*.

After the dowels have been raised, handles *F* are raised, which forces clamps *G* down on the cylinder block at two points *X*, and holds it securely. On the inner end of each shaft *H* to which handles *F* are fastened, there is a cam *J* which engages a slot in the shank of clamp *G* and raises or lowers the clamp as handle *F* is manipulated. A spring beneath the lower end of the clamp shank forces it up when handle *F* is lowered. The handle is held in the raised position by a plunger *K*.

An important feature of this operation is that each reaming tool is guided at two points—by bushing *L* in the jig bushing plate and by bushing *M* in the base. The reaming tool consists of a long spindle, which has a 9/16-inch pilot at the lower end, about 4 inches long, and a No. 2 Morse taper shank at the top. Just above the pilot are reamer cutting edges, 11/16 inch in diameter by about 3 13/16 inches long, and immediately above these cutting edges is mounted a shell reamer 1 3/4 inches in diameter. This shell reamer is a close fit on the main reamer spindle, and is driven from it through a collar that has lugs engaging the upper end of the reamer. The twelve spindles are held in a straight line by means of a special cast-steel cross-brace *N*, attached to the drill head. There are six caps *O*, each of which holds

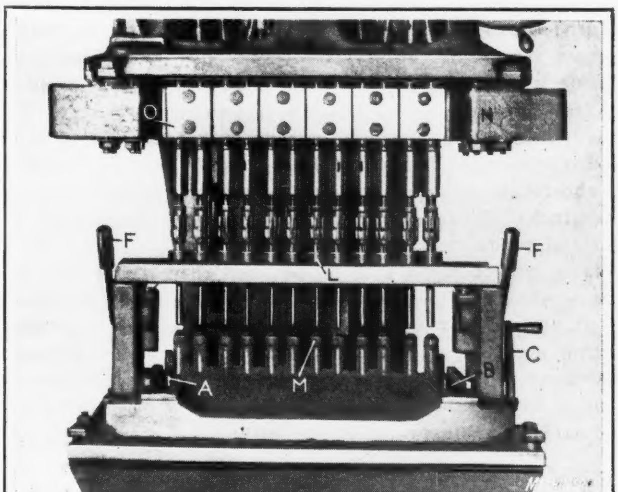


Fig. 7. Jig for reaming Twelve Guide Holes and Openings in the Top of the Cylinder Block

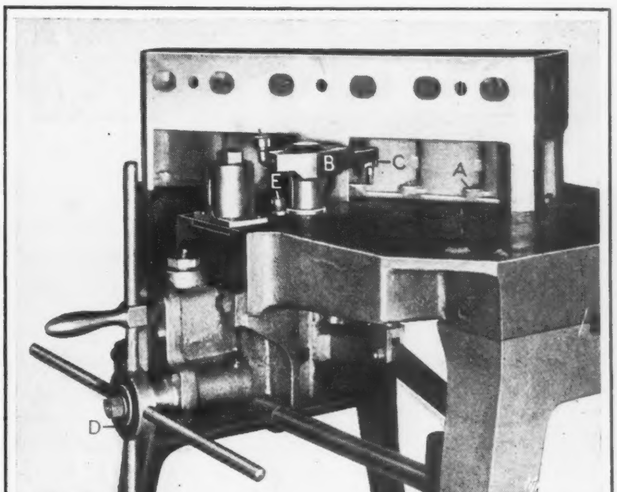


Fig. 8. Special Machine employed for back-facing Six Bosses on the Series 80 Cylinder Block

two spindles in place vertically. The bracket furnishes a strong support, and the caps facilitate the replacement of spindles as they become worn.

Back-facing the Cylinder Blocks

In machining the series 80 cylinder block, the unique operation illustrated in Fig. 8 is performed; this consists of back-facing six bosses *A*. This machine is of a special design, in which there is mounted a column that raises or lowers arm *B* as required. Arm *B* carries a back-facing tool *C*, which has a square shank that projects downward. In this operation, the cylinder block is positioned by hand, so that the tool shank will enter a hole previously drilled through one of the bosses when arm *B* is lowered by turning the spider handwheel *D*. The tool shank passes through the boss of the cylinder block and into the table of the machine, where it enters the square socket of a rotating vertical spindle. By means of this spindle the tool is rotated and the boss faced as the operator continues to lower arm *B* until it registers with stop *E*.

The drive to the vertical spindle is through bevel gears and a shaft that runs to the rear where the driving pulley is mounted. Reduction gearing is interposed between wheel *D* and the bracket column, so that the tool is not brought too suddenly into contact with the work, and the feeding is readily accomplished. The mechanism is counterbalanced.

* * *

PUNCH PRESS TOOL FOR GRADUATING BRASS VERNIER

By F. L. LIBGOTTE

The punch press tool shown in Fig. 1 is used to cut the graduations on brass vernier adjusting barrels for spirit levels employed on machine gun mountings. The brass pieces on which the graduations are cut, one of which is shown at *A*, are machined on ordinary turret lathes. As the graduations are required to be very fine, a knurl could not be depended upon to maintain the high degree of accuracy required.

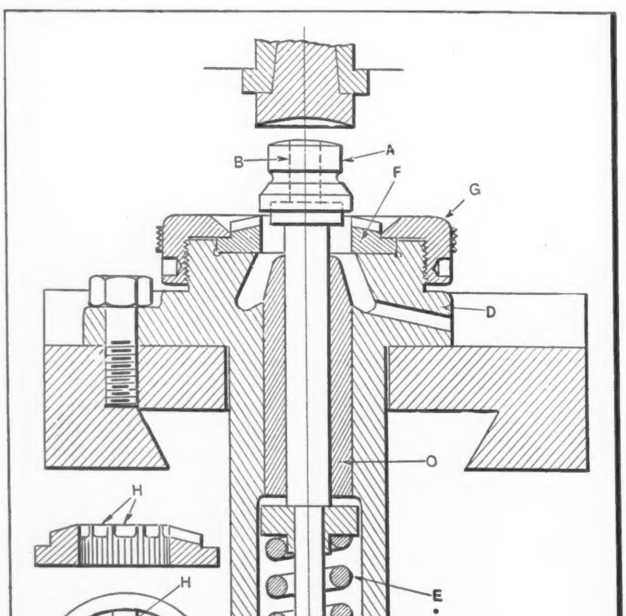


Fig. 1. Die for graduating Brass Vernier

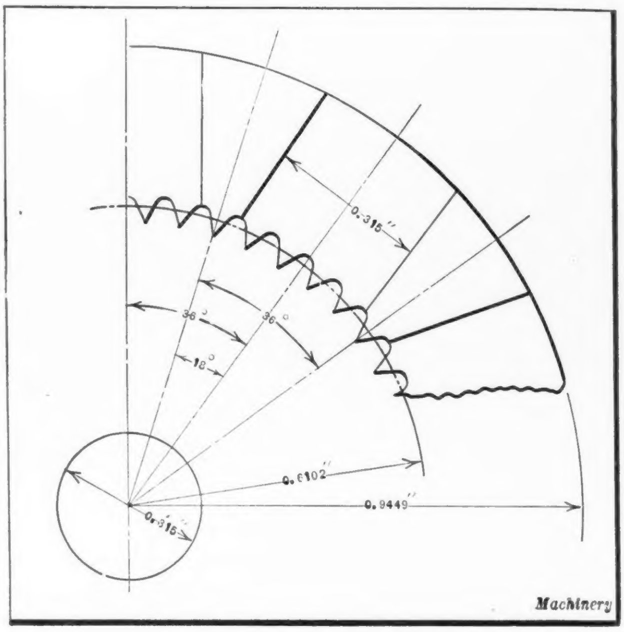


Fig. 2. Enlarged Section of Graduating Teeth on Die

The work *A* is located on a hardened and ground plug *B*, the shank of which is a sliding fit in a steel sleeve *C* which is forced into the cast-iron holder *D*. A powerful spring *E*, positioned as shown, serves to maintain an upward pressure on the locating plug *B*. At the top of holder *D* is located the graduating tool *F*. This tool is held in place in the ground recess by a knurled nut *G*. The graduating tool is made of high-speed steel in the form of a steel ring. On the inside face of this ring are cut very fine teeth of the form indicated in the enlarged view, Fig. 2. These teeth are accurately spaced to give the required graduations.

As every fifth graduation is required to be higher than the others, the top of the tool is notched, as indicated at *H*, Fig. 1. The top or cutting faces at the bottom of the notches and on the raised portions can be readily ground when the tool becomes dull. In order to grind the tool, it is pressed on a brass mandrel which is mounted in the index-block of a small grinder at the proper angle. The results obtained with this graduating tool are very satisfactory. It may be mentioned here that the graduating teeth were cut on a small Pratt & Whitney vertical shaper, using a straight cut with no taper.

* * *

IS RUSSIA COMING BACK INDUSTRIALLY?

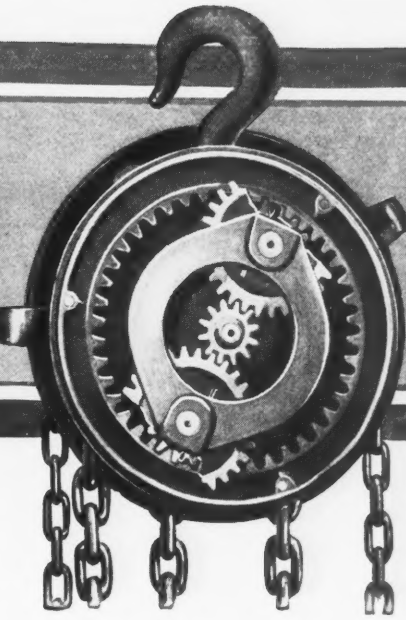
According to a statement published by the Russian Information Bureau, 2819 Connecticut Ave., N.W., Washington, D. C., a thousand tractors have been built in Russia during the last twelve months, and it is estimated that about $9,000,000 worth of agricultural machinery will be bought abroad this year. It is stated that this is the first year during which tractors have been built, and it was necessary to train workers and obtain the required machinery. For this reason, the thousand tractors built this year will be rather expensive; but it will be possible to build tractors in the future at a more moderate cost. According to F. E. Djerzinsky, chairman of the Supreme Economic Council, industrial production has reached 70 per cent of the pre-war volume, as compared with 23 per cent three years ago. At the present rate of progress, according to the same statement, the pre-war volume of production should be reached within eighteen months. If these figures are an accurate statement of conditions now existing in Russia, it is evident that there should be a materially increasing market for industrial machinery in Russia within the near future.

* * *

If all the automobiles built every day were placed end for end, they would constitute a line 31 miles long.

Planetary Gearing

By FRANKLIN DeRONDE FURMAN
Professor of Mechanism and Machine Design
at Stevens Institute of Technology



Oldham Coupling and its Graphical Solution—Analysis of Actions in Automobile Differential Gearing
Thirteenth Article

THE well-known Oldham coupling, which is fundamentally a problem in planetary gearing, is analyzed in this article and, in addition, the planetary actions of the automobile differential gear, including such cases as when the car is turning a corner; when one rear wheel is jacked up; and when both rear wheels have different traction, as when one wheel is mired. The spur wheel gear is first illustrated, and solved by both the graphical and analytical methods for the cases referred to. The bevel wheel differential is then similarly treated. The action that takes place when both rear wheels are jacked up and one wheel is turned, is also explained.

Oldham Coupling

Although it is generally known that the Oldham coupling transmits motion at every phase with uniform angular velocity, the reason for this is not generally understood, nor is it realized that the coupling disk makes two turns for each turn of the shafts. Both of these points will be demonstrated. The varied paths of motion of several points of the coupling disk will also be traced for a full cycle, thus explaining the apparent wobbling motion that this disk has in its practical application.

The action of this coupling, which is used for shafts that are not in line, is similar to an internal planetary wheel that rolls on a pinion of half its size. The coupling piece is simply a disk YZ, Fig. 70, with a tongue cut on each end. These tongues R and U are at right angles to each other. Each tongue fits into a diametral slot cut in the end of the shaft. If the shaft Q is driving with uniform angular velocity, the shaft S, although out of line, will be driven through the coupling with an equal angular velocity. This latter fact, together with the extreme simplicity of construction and the wealth of theory of mechanism that is in it, makes it, in the author's estimation, the most remarkable elementary mechanism ever devised.

Before taking up the Oldham coupling as a planetary gear mechanism, it may prove useful to demonstrate by velocity lines and simple geometry that this coupling does transmit motion without any variation whatever in angular velocity. In Fig. 71, Q and S are the centers of the driving and follower shafts, while A represents the center of the coupling disk at any phase. Since A is at the junction of two tongues at right angles to each other, and since these tongues fit in diametral slots in the two shafts, it follows that they will always point to, and pass through, the fixed points Q and S. It also follows from this that the point A of the coupling disk must travel in the path of the circle $QASC$, and that this point A must, at the phase shown in Fig. 71, be moving in the general direction AB_2 tangent to the circle. If now the shaft Q is turning at such a rate that the point A in the slot in Q is moving with a linear velocity AB, the point A in the disk, which has just been shown to have a resultant motion in the general direction AB_2, will have a definite linear velocity AB_2 found by drawing BB_2 perpendicular to AB. Since the point A in the slot V in the shaft S must have a motion perpendicular to the line SA, and since this motion must be imparted by point A in the coupling disk, the point A in the slot will have a linear velocity AB_1 found by drawing B_2B_1 perpendicular to AB_1.

It now remains to show that the linear velocity AB divided by the radius QA from center of driving shaft to disk center is equal to the linear velocity AB_1 divided by the radius SA from center of follower shaft to disk center, or expressed as a formula

$$\frac{AB}{AQ} = \frac{AB_1}{AS}$$

The right triangles AQS and BAB_2 are similar, because the angles AQS and BAB_2 are equal. This statement may need the further explanation that the angles BAB_2 and MAQ are equal, being formed by lines respectively perpendicular to each other; and the angles MAQ and AQM are equal, because the triangle MAQ is isosceles. Therefore, from the properties of similar triangles, $\frac{AB}{AQ} = \frac{AB_1}{AS}$. Interpreted in words, this means that the follower shaft S has exactly the same angular velocity as the driving shaft Q at all phases in the cycle.

As a problem in planetary gearing, the Oldham coupling consists of a driving sun wheel D, Fig. 72, and an internal planet wheel D_3. The planet wheel is specially constructed with a plate face in which two diametral slots are cut, as shown at RV and UT. It is set up so that these slots slide on the rectangular heads of two pins Q and S, which are free to turn on their axes. These pins, which represent the two shafts in the practical application of the Oldham coupling, are specially located on the extremities of a diametral line equal in length to the diameter of the sun wheel D.

With the planet wheel so set up, its center A_1 will always be on a circle A_1A which coincides with the sun wheel pitch circle. Also, the instantaneous axis of the planet wheel, which is at A for the phase shown, will always be on the circle AA_1. This last statement may be best understood if it is observed that the point Q on the planet wheel can have a resultant motion only in the direction QB_4; and the point S only in the direction SB_5. Perpendiculars to these two directions, when drawn at Q and S, meet, by geometry, at the point A on the circle AA_1, and A is therefore, by definition, the instantaneous axis of the planet wheel at the phase shown.

Although the sun wheel D supplies the motive power for the mechanism, it is, in reality, the pins Q and S that deter-

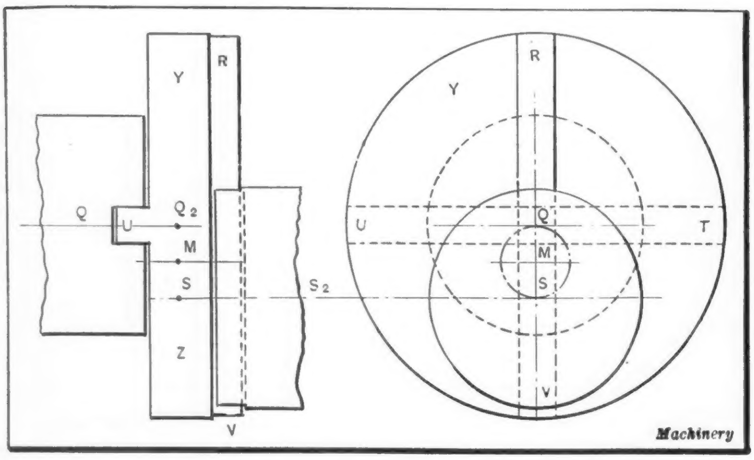


Fig. 70. The Oldham Coupling, which compensates for Lack of Alignment between Two Shafts

mine the velocity and direction of every point on the planet wheel, and the same effect, precisely, could be obtained by discarding the driving sun wheel D and placing a train arm MA_1 in its stead. A pin in the train arm at A_1 would then drive the point A_1 in the planet wheel, in the path of the circle A_1A, and again the pins at Q and S would compel the planet wheel to move in identically the same way as before. In the latter case, where a train arm is used, the pitch circle of the planet wheel D_3 would roll on a fixed imaginary sun circle AA_1, just as it does on the real pitch circle of the sun wheel when a sun wheel is used.

Graphical Solution of Oldham Coupling

Coming to the graphical solution of the Oldham coupling, considered as a planetary device, let AB represent the velocity of A of the sun wheel pitch circle. Then AB is also the velocity of the instantaneous axis A of the planet wheel; and further, it is the velocity of the center A_1 of the planet wheel, because the points A and A_1 of the planet wheel are always diametrically opposite each other and both travel in the path of the same circle AA_1, as described in the preceding paragraph. With AB as the linear velocity of A on the sun wheel D, $\frac{AB}{AM}$ will be a measure of the angular velocity or speed of the sun wheel. With A_1B_1, equal to AB, as the linear velocity of A_1 on the planet wheel D_3, $\frac{A_1B_1}{A_1A}$ will be a measure of the angular velocity of the planet wheel about its instantaneous axis A. Therefore, $\frac{AB \div AM}{A_1B_1 \div AA_1}$ represents the relative angular velocities of the sun and planet wheels, and since $A_1B_1 = AB$, and $AA_1 = 2AM$, the compound fraction just given may be rewritten, $\frac{AB}{AM} \times \frac{2AM}{AB} = 2$, the sun wheel D turning about M with twice the speed of the planet wheel D_3 about its instantaneous center A.

Since the point A_1 of the planet wheel D_3 is turning about the instantaneous axis A with a linear velocity A_1B_1, the angle a will represent the angular velocity of A_1; and all other points in the planet wheel must have the same angular velocity about the instantaneous axis. Therefore, by laying off the angles a_1 and a_3 equal to a, the resultant linear velocities QB_4 and SB_5 will be obtained for the points Q and S, respectively, on the planet wheel.

Since Q has a turning velocity of a_1 about A (both being points in the planet wheel D_3), the point A may be regarded as having a turning velocity of a_2, equal to a_1, about Q; in other words, the planet wheel D_3 has a motion of rotation about the center of pin Q equal to a_2, and because of the slot in D_3 and the rectangular head on the pin Q, the pin is being turned with the velocity a_2. The same argument holds for pin S, and therefore it follows that the pins Q and S are each turning with the same angular velocity a_2. Since a_2 is equal to a, it follows that the two pins Q and S, which represent the shafts in the Oldham coupling, are each turning with the same speed, and that this speed is one-half that of the sun wheel D. By measuring the values in the following formula, as they are shown in Fig. 72,

$$N = \frac{AB \div AM}{AB_4 \div AQ} = \frac{AB \div AM}{QB_4 \div QA} = \frac{AB \div AM}{SB_5 \div SA}$$
$$= \frac{8}{12} \times \frac{12}{4} = \frac{8}{12} \times \frac{12}{4} = \frac{8}{12} \times \frac{21}{7} = 2$$

The sun wheel D, therefore, makes two turns to one turn of each of the pins Q and S. (The notation used is given at the end of the article.) Analytically, the following formula is used

$$N = 1 + 2 \times \frac{D}{D_3} = 1 + 2 \times \frac{18}{36} = 2$$

A curious consequence of the action of this mechanism is that the center A_1 of the planet wheel D_3 makes two complete circuits in the circumference of the circle whose diameter is A_1A while the slots in the face of the same planet wheel turn the pins Q and S only once. The coupling disk in the Oldham coupling has a peculiar wobbling motion due to the fact that all points in the disk describe trochoidal curves of different proportions. These curves vary from the internal epicycloid GA, Fig. 73, which is traced by the points G and A, through the looped internal epitrochoids M_1AM, HAH_1 etc., to the circle A_1A.

Differential Gearing of an Automobile

The automobile differential gear is a planetary mechanism that acts as such when the car is not running in a straight line direction, and also when one rear wheel has a different traction hold from the other. It also works as a planetary mechanism when the rear end is jacked up, the engine not running, and one wheel turned. When running straight ahead there is no planetary action; in fact, there is no relative motion at all of the several parts. The mechanism is readily constructed either with spur gear wheels or bevel wheels. The former type will be considered first.

In Fig. 74, J represents the engine shaft with a bevel driving pinion that gears with the wheel K. Wheel K carries several sets of pins, usually three sets, one of which is shown at O and Q. Each of these pins has keyed to it a broad planet wheel D_3 and D_4, respectively, and these wheels overlap and gear with each other and with the sun wheels D_1 and D'_1, respectively. The wheels D_1 and D'_1 are keyed to the ends of the shafts R and L, which drive the right and left rear wheels of the car. The housing T, which carries

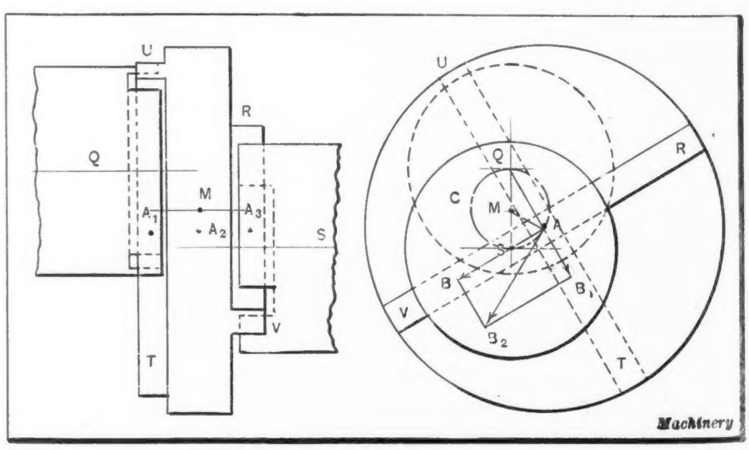


Fig. 71. Diagram illustrating why Oldham Coupling transmits Motion without Variation in Angular Velocity

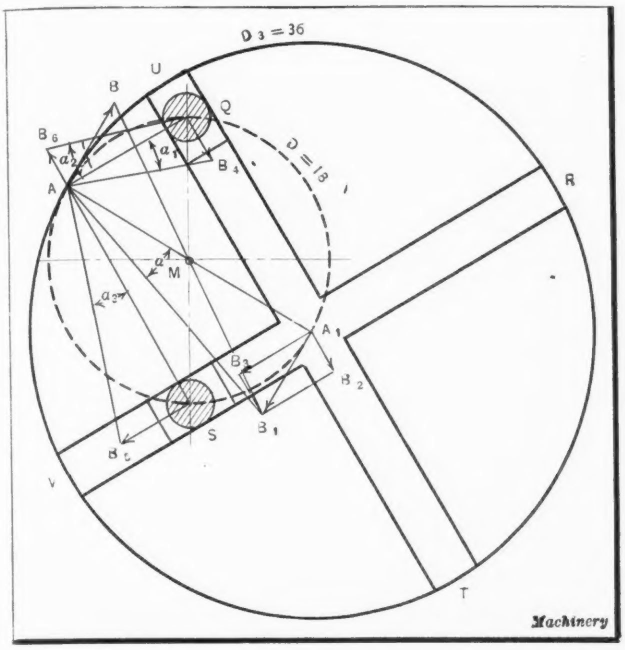


Fig. 72. Oldham Coupling arranged as a Planetary Gear Mechanism

the planetary pins, turns freely on the shafts R and L. Both sun wheels must be the same size, and both planet wheels must also be the same size. The former have thirty-six teeth and the latter twelve teeth each, in this case.

When the engine is driving the car straight ahead, the entire differential gear mechanism turns as one solid piece, as indicated by the graphical solution in Fig. 74. If the engine is driving the shaft J as indicated by the arrow, the wheel K will turn clockwise, and the pins O and Q will have a linear velocity which may be represented by AB and A_1B_1, equal to each other. If both car wheels have the same traction hold, each offers the same resistance to the shafts R and L and to the sun wheels D_1 and D'_1. Since the planet wheels tend to roll on the sun wheels, as indicated by the arrows at G, and since they both meet the same resistance, their tendency to roll is checked because the front overlapping portion of D_3 tends to turn clockwise while the rear overlapping portion of D_4 tends to turn counter-clockwise; hence the teeth of the planet wheels, which are in engagement at G, are in a state of balance at that point, with no relative motion between them, and remain so as long as the rear car wheels offer the same resistance. Therefore, both sun wheels D_1 and D'_1 will be driven with the same linear velocity PE and P_1E_1, respectively, and there will be no relative motion of any of the parts of the mechanism.

Action When One Rear Wheel is Held Stationary

The simplest planetary action, with the engine running, occurs when the traction is such that one car wheel is held stationary while the other turns freely. In this case, the engine drives the pins O and Q with the same velocities A_2B_2 and A_3B_3 as before. If the right car wheel is held stationary, D_1 cannot turn, and C_2 becomes the instantaneous axis of the planet wheel D_3. The point G_2 on this wheel is then moving in a resultant direction perpendicular to C_2G_2, and the point G_2 on the planet wheel D_4 has the same resultant motion; hence the instantaneous axis of the wheel D_4 must be in the line C_2G_2 extended. It must also be in the line MA_3 extended, because the point A_3 on D_4 has a resultant motion in the direction A_3B_3; hence the instantaneous axis of D_4 must be at C_3.

If A_3 has a velocity of A_3B_3 about C_3, the point P_3 on the planet wheel, and also the point P_3 on the sun wheel D'_1, will have the linear velocity P_3E_3. In order to compare the angular velocity of D'_1 with that of the housing and wheel K, P_3E_3 must be increased to A_3F by drawing a straight line through M and E_3. Then $N' = \dfrac{A_3F}{A_3B_3}$, or, measuring these values to any convenient scale, $N' = \dfrac{8}{4} = 2$, which means that the sun wheel D'_1 and the left car wheel make two turns to one turn of wheel K, when the right car wheel is held stationary.

The analytical solution for this case is written as follows:

$$N' = 1 + \frac{D_1}{D_3} \times \frac{D_4}{D'_1}, \text{ or } N' = 1 + \frac{36}{12} \times \frac{12}{36} = 2$$

Action of Differential When Car is Turning a Corner

When the car is turning a corner, or moving in any curved path, or when the tires are not uniformly inflated so as to give the same effective radius to the wheels, there will be relative motion in the gear and it will act as a planetary mechanism, according to the same general principles as those explained in the preceding paragraph. Briefly, the engine drives the shaft J, the wheel K, and the planet pins O and Q, the latter receiving the same linear velocity as before, as represented by A_4B_4 and A_5B_5, respectively. In this case, however, the right car wheel is not held entirely stationary but has a slight motion represented by P_4E_4; consequently, C_4 is the instantaneous axis of D_3.

By drawing C_4G_3 and MA_5 and extending them, C_5 is obtained as the instantaneous axis of planet wheel D_4, from which the resultant motion P_5E_5 is obtained at P_5. Increasing this linear velocity to unit radius, it becomes A_5F_1, and $N' = \dfrac{A_5F_1}{A_5B_5} = \dfrac{7}{4} = 1.75$; in other words, the left car wheel makes 1 3/4 turns while wheel K makes one turn when the right wheel turns slightly, as represented at P_4E_4. As the right wheel turns faster, N' approaches unity. In this case, the value P_4E_4 was taken so that the right wheel turned only at one-quarter the speed of wheel K. This definite figure was obtained by making A_4I equal to one-fourth A_4B_4 and drawing IM to get P_4E_4.

Solved analytically,

$$N' = 1 + \frac{D_1}{D_3} \times \frac{D_4}{D'_1} - \frac{1}{4} \times \frac{D_1}{D_3} \times \frac{D_4}{D'_1}$$

$$= 1 + \frac{3}{4} \times \frac{36}{12} \times \frac{12}{36} = 1.75$$

Action When Both Wheels are Free to Turn

If the engine is stationary and the rear axle jacked up so that the two wheels are free, it will be found that when one wheel is turned in one direction, the other wheel will

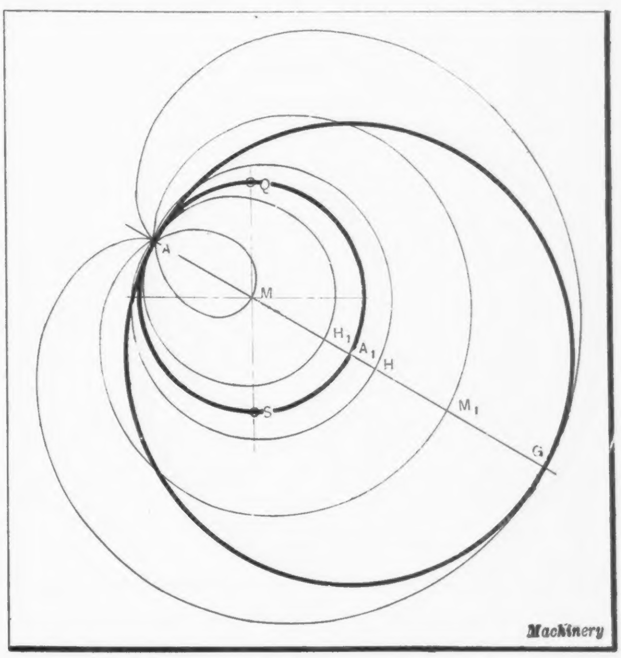


Fig. 73. Showing Paths followed by Different Points on the Coupling Disk of an Oldham Coupling

turn with the same velocity in the opposite direction. In this case, there is no planetary action, because the pins O and Q, which carry the planet wheels D_3 and D_4 are stationary, and the problem is one of simple gearing, as shown graphically in the illustration. If the right rear car wheel is turned clockwise, the point A_6 on the sun wheel will have a linear velocity represented by A_6B_6. This will also be the linear velocity of A_6 on the planet wheel, which now turns on the fixed center C_6. It will also be the velocity of the points G_4 on the wheels D_3 and D_4, as shown at G_4B_7, as well as of the point P_6 which drives the follower sun wheel D'_1. The velocity at P_6 is shown at P_6B_8, which is made equal to A_6B_6. Hence,

$$N = \frac{+A_6B_6}{-P_6B_8} = \frac{+4}{-4} = -1$$

Analytically,

$$N = \frac{D_1}{-D_3} \times \frac{+D_4}{-D'_1} = \frac{36}{-12} \times \frac{12}{-36} = \frac{+1}{-1} = -1$$

keyed to the rear wheel axles R and L, and if both wheels have equal road traction, the sun wheels will offer equal resistance at P_1 and P. Under these conditions each bevel pinion, as at D_3, will simply act as a moving beam with a driving action at A which it transmits to P_1 and P; and there will be no relative motion between the bevel pinion D_3 and the sun wheels D_1 and D'_1.

This is shown graphically in the view at the right, Fig. 75, where A_1B_1 is the driving velocity on the pin O of D_3, and P_2E_2 and P_3E_3 are the driven velocities given to the bevel sun wheels D_1 and D'_1. Since A_1B_1, P_2E_2 and P_3E_3 are all at equal distances from the main axis LR,

$$N = \frac{A_1B_1}{P_2E_2} = \frac{A_1B_1}{P_3E_3} \text{ and } N = \frac{1}{1} = 1$$

This means that wheel T, which corresponds to the train arm in the ordinary spur gearing, makes one turn while the sun wheels D_1 and D'_1 and the wheel axles R and L make one turn. In this case, of course, there is no planetary motion, as well as no relative motion of the wheels,

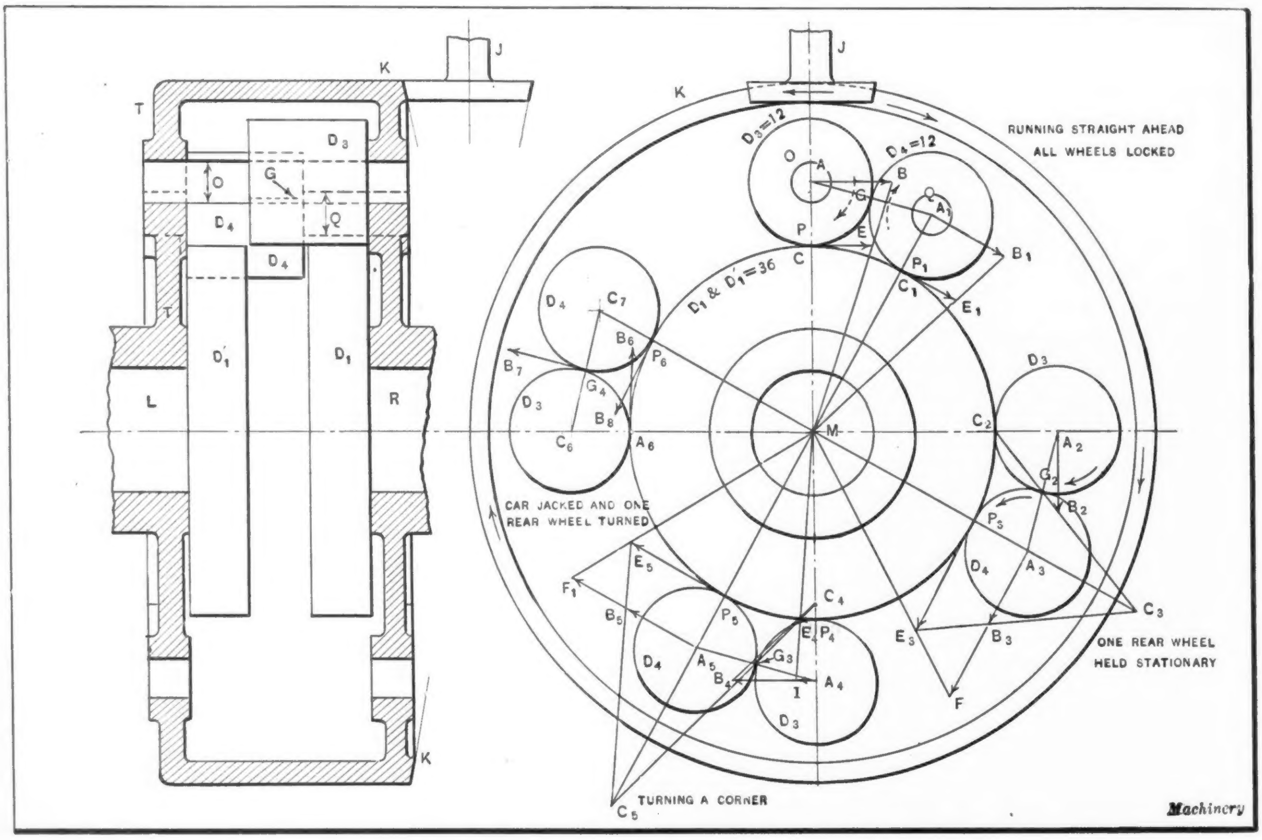


Fig. 74. Diagram illustrating Spur Gear Type of Automobile Differential, including Graphical Solutions for Different Running Conditions

or one turn of one of the rear wheels produces one turn of the other wheel in the opposite direction.

Procedure When Differential is of Bevel Gear Type

Bevel gear wheels may also be used in planetary mechanisms without any change in the application of the principles used in the graphical and analytical methods of solution. The detail construction for the graphical method, however, must be modified to apply to the form of the bevel wheel, as shown in Fig. 75, which represents the bevel wheel type of differential gearing, now commonly used in automobiles.

When the automobile is running straight ahead, the driving shaft J, which is connected with the engine shaft through the transmission gear, turns as shown by the arrow, thus turning the large bevel wheel T in the direction indicated by the arrow at T_1. The wheel T supports three or four bevel pinions D_3, etc., which are free to turn in their bearings, as at O and Q. As the wheel T is turned on its axis LR, it carries the pins O and Q bodily around this axis, and these pins do not turn on their own axes if the sun wheels D_1 and D'_1 offer equal resistance. These sun wheels are and hence no analytical formula to be written. All parts revolve as one solid piece.

Relative motion and planetary action both take place when the car turns a corner, or when one wheel spins and the other is held stationary. The latter case, which is identical with lifting only one rear wheel and running the engine, offers the simpler solution, and will be illustrated first. Let A_3B_3 be the velocity given to pin O of the bevel pinion. Assuming that the car wheel that is connected by shaft L to D'_1 has no traction and is spinning, and that the other rear wheel remains stationary, then the point C on the bevel pinion will be held stationary, and the point P_4 on both the pinion and the sun wheel D'_1 will be driven with the velocity P_4E_4. Since A_3 is the center of the pinion and midway between C and P_4, and since A_3B_3 and P_4E_4 are equidistant from the axis LR,

$$N' = \frac{P_4E_4}{A_3B_3} = \frac{2}{1}$$

or the follower sun wheel D'_1 and its car wheel make two turns while wheel T, or the train arm, makes one turn.

The analytical formula applies in this case just as in spur gearing, and, briefly, is as follows: The entire mechanism is turned once counter-clockwise about M_1; then $N' = 1$. In this problem D_1 was assumed to be stationary, and hence has had one turn that it should not have, and must now be turned back while the pin O remains in its revolved position. In turning D_1 back, the pinion D_3 turns counter-clockwise also, and thus drives D'_1 in a clockwise direction. Hence $N' = 1 +$. If D_1 has 35 teeth, D_3 15 teeth, and D'_1 35 teeth, D_1 will drive D'_1, $\frac{35}{15} \times \frac{15}{35}$ turns while it turns once.

Thus the complete analytical formula

$$N' = 1 + \frac{D_1}{D_3} \times \frac{D_3}{D'_1}$$

is now written, and substituting values for D_1, D_3, and D'_1,

$$N' = 1 + \frac{35}{15} \times \frac{15}{35} = 2$$

Measuring these values to any convenient scale,

$$N' = \frac{7}{4} = 1.75$$

Analytically, the formula is written

$$N' = 1 + \frac{D_1}{D_3} \times \frac{D_3}{D'_1} - \frac{1}{4} \times \frac{D_1}{D_3} \times \frac{D_3}{D'_1}$$

$$= 1 + \frac{3}{4} \times \frac{35}{15} \times \frac{15}{35} = 1.75$$

or the left car wheel makes 1 3/4 turns while wheel T makes one turn, provided the right car wheel has an independent motion due to traction of one-fourth turn in the same time, all motions being in the same direction. For convenience in drawing, the rate of turning of the rear wheel was taken as one-fourth that of the wheel T. This represents turning a corner of very short radius. In turning a corner of larger radius, the wheel connecting with D_1 would turn, say, with three-fourths the speed of T, and the left car wheel would

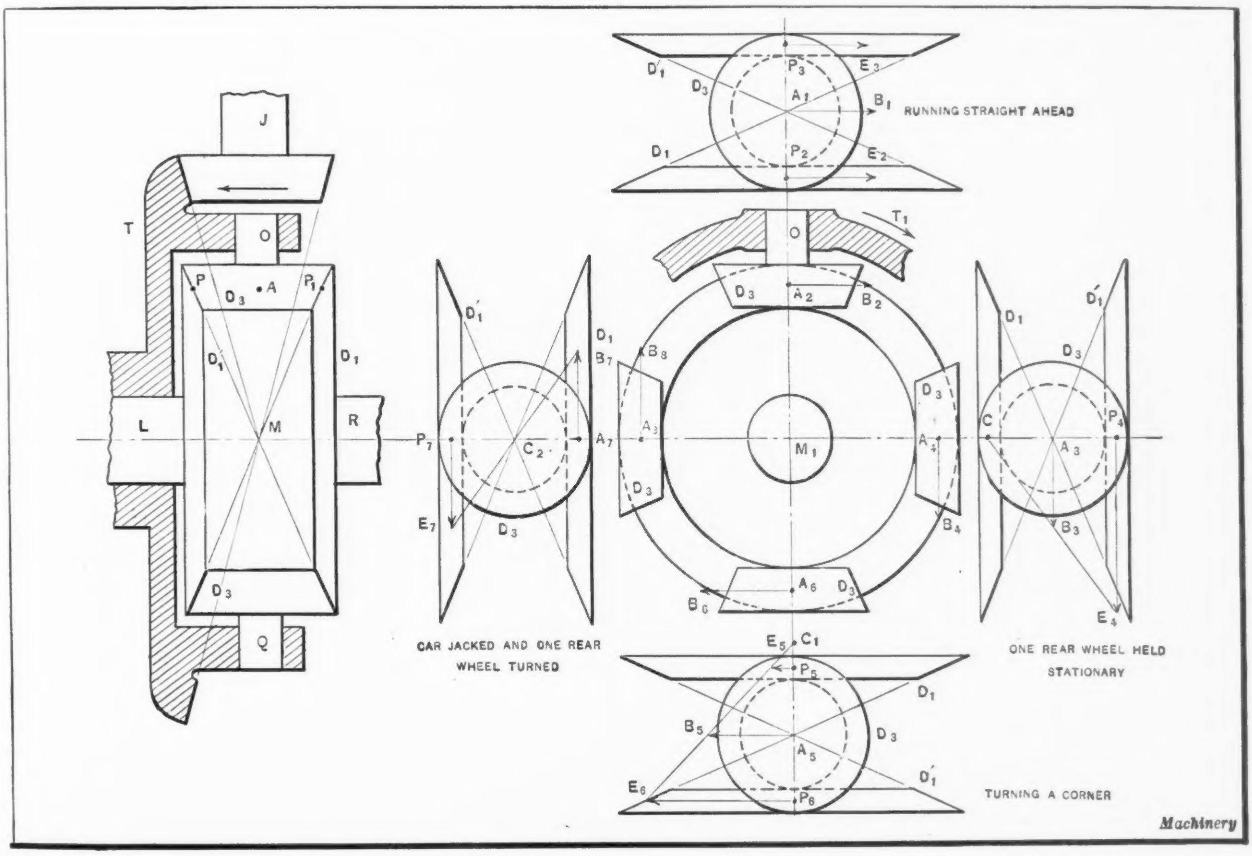


Fig. 75. Diagrams illustrating Bevel Gear Type of Automobile Differential, with Graphical Solutions for Different Motions

When the automobile is traveling in a curved path, one wheel will have less turning action than the other, provided the road traction is equal for both wheels, because one wheel is traveling in the path of a shorter circular arc than the other wheel. The same effect is produced if the car is traveling straight ahead and one rear wheel tire is inflated less than the other so as to produce a shorter effective radius of the wheel. In this case, the wheel having the less inflated tire will turn faster than the wheel having the fully inflated tire.

Applying the graphical solution to the cases just described, let it be assumed that the right rear wheel, because of the nature of the road traction, is compelled to turn on its axis with a velocity one-fourth that of wheel T of the differential mechanism. Then P_5E_5 equals one-fourth A_5B_5. Joining B_5 and E_5 by a straight line and extending it, C_1 is found to be the instantaneous axis of the bevel pinion. Hence the point P_6 on both the planetary pinion D_3 and the follower sun wheel D'_1 has the velocity P_6E_6 and $N' = \frac{P_6E_6}{A_5B_5}$.

then turn with 1 1/4 times the speed of T. It may be of interest to note that while this action is going on, the planet wheel pinion D_3 is turning in the bearing O at a rate represented by $\frac{A_5B_5}{A_5C_1}$, which measured to scale gives $\frac{4}{4} = 1$, while wheel T is turning at the rate $\frac{A_5B_5}{A_6M_1} = \frac{4}{7}$. Hence the planetary pinions are turning on their own axes with 1 3/4 the speed of the driving wheel T. If one rear wheel is held stationary, as described in the preceding paragraph, the planetary bevel pinions will be turning on their axes with a relative velocity of $\frac{A_3B_3}{A_3C} \div \frac{A_3B_3}{A_4M_1} = \frac{4}{3} \times \frac{7}{4} = \frac{7}{3}$ or 2 1/3 times the velocity of wheel T, for the wheel sizes used in this illustration.

The remaining case that is of especial interest in this differential gear mechanism occurs when the rear axle is jacked up so that both wheels are off the ground, and one wheel turned, the engine not running. Then the other wheel

turns in the opposite direction, with the same speed as the driving wheel. This case also is illustrated in Fig. 75, where A_7B_7 represents the velocity given to the right rear wheel, and hence, by construction of the mechanism, to the sun wheel D_1. Since the center of the planetary pinion is now fixed, because the engine is not running, the velocity A_7B_7 given to the pinion will be transferred to P_7E_7, which will be the velocity of the follower sun wheel D'_1 and of the left rear car wheel; hence

$$N' = \frac{-P_7E_7}{+A_7B_7} = \frac{-4}{+4} = -1$$

Analytically, the formula reduces to one for simple gearing where fixed centers are used, and

$$N' = \frac{+D_1}{D_3} \times \frac{D_3}{-D'_1} = \frac{+35}{15} \times \frac{15}{-35} = -1$$

or, the follower wheel D'_1 and the left rear wheel make one turn counter-clockwise while the right wheel makes one turn clockwise.

Notation

N = number of turns of driver to one of follower or driven member;

N' = number of turns of follower to one of driver;

N_1 = number of turns of driver to one complete revolution of planet wheel axis;

N_2 = number of turns of follower to one complete revolution of planet wheel axis;

D = diameter of pitch circle of driver, if driver is a toothed wheel;

D_1 = diameter of pitch circle of follower, if follower is a toothed wheel;

D_2 = diameter of pitch circle of fixed wheel; and

D_3, D_4, etc., = diameters of pitch circles of planetary wheels.

* * *

HARDENING A DIE THAT IS SUBJECT TO SHRINKAGE

By CLAYTON WHEELER

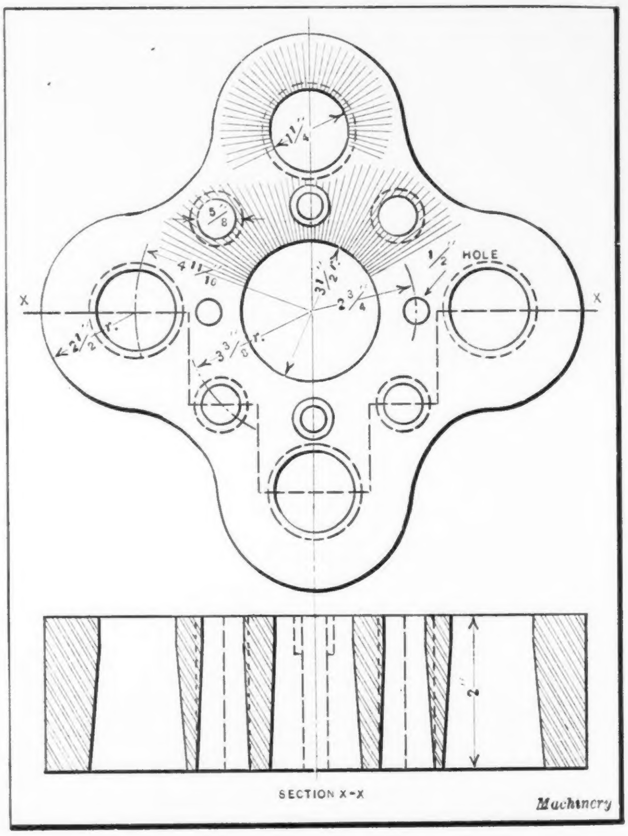
The die-plate shown in the accompanying illustration was designed for use in blanking and piercing 1/8-inch sheet stock at one stroke of the press. The clearance between the punches and the holes in the die-plate is 0.0125 inch. As the plate was required to be hardened and to be held to close limits, some complicated grinding operations were involved. Though the plate was made of a good grade of non-shrinkable tool steel, its unusual shape and the large number of piercing holes made it impossible to prevent a certain amount of shrinkage.

The plate was first rough-turned to within 3/32 inch of the finished dimensions, and then annealed at a temperature of about 1350 degrees F. It was next finished on the blanking edges to the size of the blank desired, plus an allowance of 0.008 inch to compensate for the shrinkage and distortion anticipated as a result of the hardening process. The fact that the steel was supposed to be non-shrinkable was reassuring, but could hardly be depended upon in this case to prevent some change in form.

As expected, the die contracted toward the center and toward the four large outside holes. The direction of shrinkage is indicated by the shade lines in the upper portion of the piece. Inspection of the plate after hardening showed that the allowance of 0.008 inch had been just enough to compensate for the shrinkage in most places, but on some surfaces it was necessary to grind away several thousandths inch of surplus stock. This applied only to the outside surfaces.

The center piercing hole required the removal of 0.018 inch of stock, and the smaller holes, 0.012 inch. The outside of the die was ground by hand to fit a templet, after which the plate was set up on the faceplate of the grinding machine and properly centered by an indicator applied to its outer edge. With the work in this position, the central hole was ground to size and a ground plug made to fit in this hole. The plug was next fastened to the faceplate, being set to one side of the center a distance of 4 11/16 inches. The die-plate was then located on the plug, thus permitting the four outside holes to be easily centered on the faceplate. After grinding one hole, the work was indexed to the next hole, and the operation repeated until all four holes had been ground. The same method was used in grinding the holes located on the 3 3/8-inch radius and those on the 2 3/4-inch radius.

In hardening the plate, all holes were packed with asbestos packing. The center hole first had a steel plug 1/2 inch smaller than the inside diameter located in a concentric position with the asbestos packed tight around it. In order to prevent the edges of the holes from being left soft, the asbestos was kept back from the cutting edge of each hole a distance of at least 1/4 inch. The plate was first heated



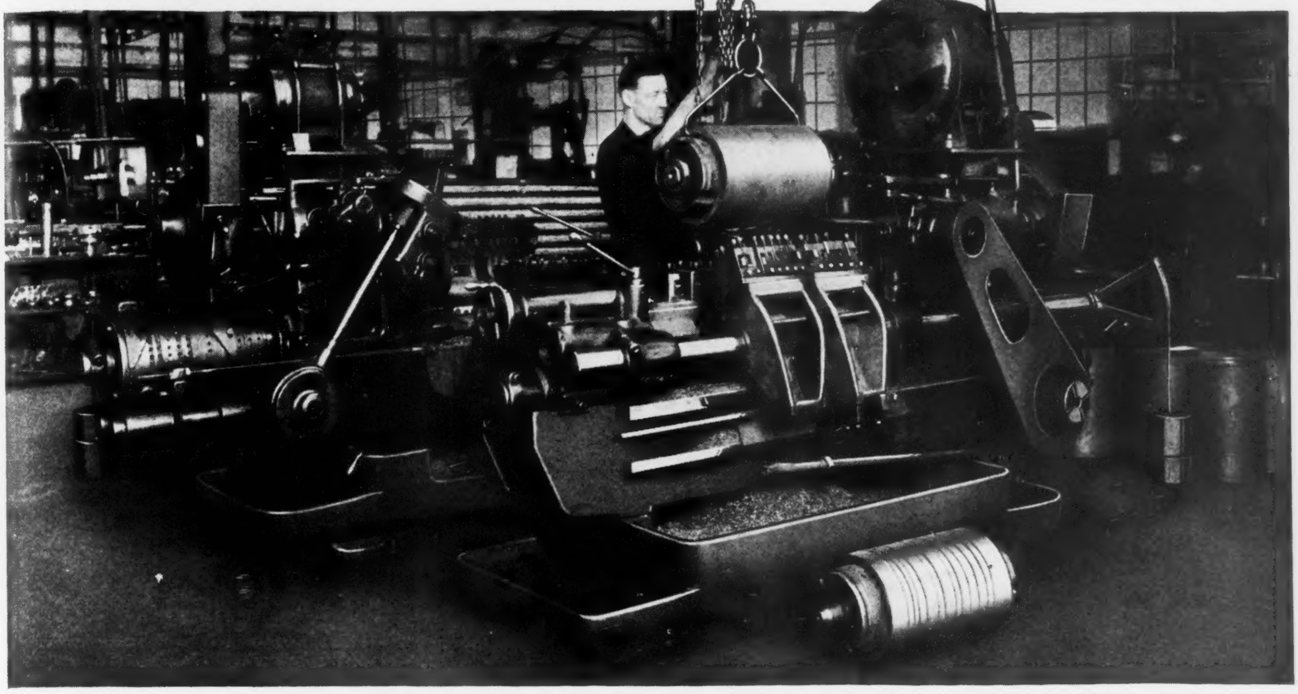
Type of Die that shrinks excessively when hardened

slowly to a temperature of 1400 degrees F., and then heated quickly to 1475 degrees F., and dipped edgewise in oil.

The plate was withdrawn from the oil when it had cooled to a temperature of about 350 degrees F., and placed in drawing oil having a temperature of 350 degrees, which was then brought up slowly to 475 degrees and held at this point for 2 1/2 hours. The part was allowed to cool down with the drawing oil. It should be borne in mind that the failure of a part to hold true to form when hardened is not always the fault of the steel, for in a great many cases the shape of the part is such that it would be practically impossible for any steel to withstand the stresses set up without showing some distortion.

* * *

Those interested in industrial conditions in Germany will find a great deal of information in the general survey of labor conditions in Germany since the war, contained in Bulletin No. 380 of the United States Bureau of Labor Statistics, Washington, D. C., just issued. The report covers standards of living, cost of living, wages, hours of labor, and unemployment up to the end of 1924. Conditions in Germany have changed greatly in the last six months, but the bulletin contains an interesting historical record of this period in German industry.



Machining a Large Cam Drum

Tooling Equipment Employed on a Fay Automatic Lathe, Turret Lathe, and Drilling and Grinding Machines

By H. A. LOUDON

SEVERAL unusual examples of tooling used in machining the large cam drum with which Fay automatic lathes are equipped will be described in this article. The drum is an iron casting, finished 19 1/4 inches long and 12 inches outside diameter. With the exception of certain surfaces of several lugs on the inside of the drum at the left-hand end, as shown at *A* in Fig. 1, the drum is finished all over. Eight grooves, 0.640 inch wide, with a plus limit of 0.000 inch and a minus limit of 0.008 inch, and one groove 1.505 inches wide, with a plus limit of 0.010 inch and a minus limit of 0.000 inch, are turned around the periphery to a depth of 1/8 inch. The right-hand end of the drum is also turned to the same depth for a width of about 2 1/2 inches. One-half inch holes are drilled and tapped every 10 degrees around these grooves and around the reduced diameter at the right-hand end, there being a total of 395 holes of this size and in addition, a 1-inch hole *B*.

Turning, facing, and grooving cuts are taken on the outside surfaces of the drum in two Fay automatic lathes, one of which roughs and the other finishes the work, while boring and threading cuts are taken on the inside of the drum in a Jones & Lamson flat turret lathe. The floor-to-floor time on the roughing automatic lathe is 18 1/2 minutes; on the finishing automatic lathe, 16 1/2 minutes; and on the turret lathe 1 1/2 hours. All these cuts were formerly taken in a single machine tool of different type from those mentioned, the time consumed in finishing them being from 4 1/2 to 5 hours. Moreover, a skilled mechanic was required when the former method was employed. With the present method, one operator tends both machines.

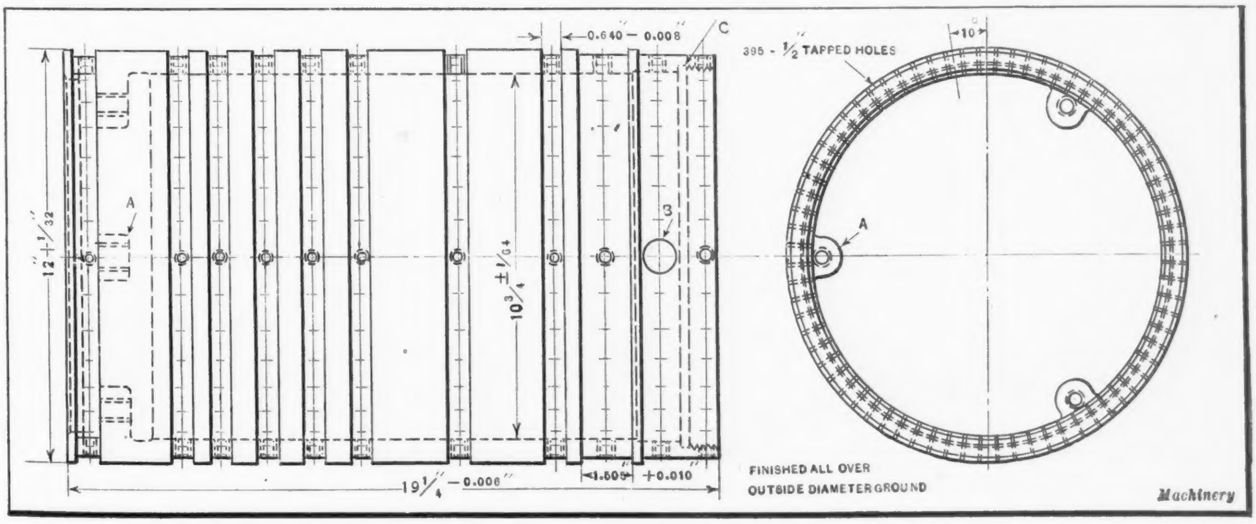


Fig. 1. Design of the Cam Drum with which Fay Automatic Lathes are equipped

Fig. 2. Placing the Work-holding Arbor in a Rough Drum Casting prior to the First Operation

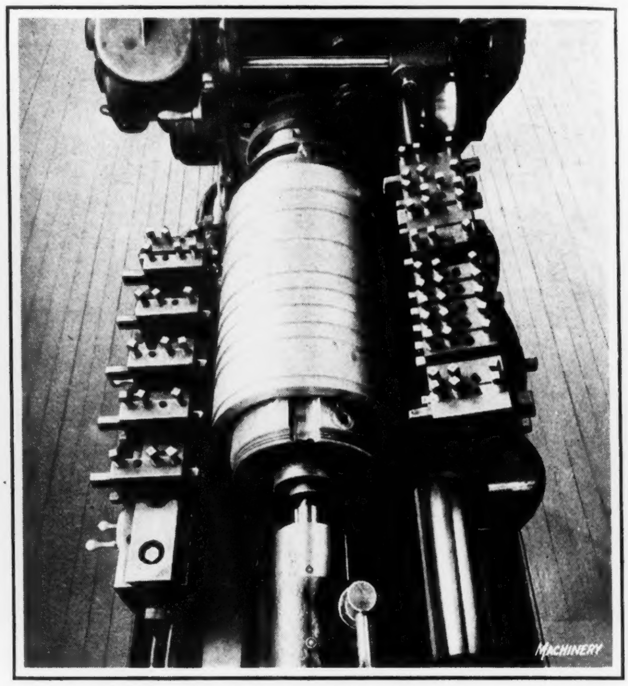


Fig. 3. Close-up View of the Tooling employed on the Fay Automatic Lathe for machining a Cam Drum

For both automatic lathe operations, the drum is mounted on a special arbor which is equipped on each end, as shown in Fig. 2, with a 9-inch chuck having swivel jaws. Keyed to each jaw is a small plate *D*, which is dished slightly in the center to give each jaw two bearing surfaces. This design prevents distorting the drum when it is gripped on the inside. The three lugs *A*, Fig. 1, in one end of the drum, fit recesses *E*, Fig. 2, in the chucks for locating purposes. Plate *F*, which is screwed in one of the chucks, is slotted in two places so that it may be engaged by driving pins on the spindle plate. To insert the arbor into a drum, the casting is placed on a wooden platform, and the arbor is lowered into it by means of a hand crane. The chuck jaws are then tightened, after which the drum and arbor are ready to be lifted into the machine by the crane.

Tooling Used on Automatic Lathe for Machining Cam Drum

Fig. 3 shows the tooling used in the finishing operation, which is similar to that used in the roughing operation. In the roughing operation, the tools mounted on the front carriage rock forward to cut to the desired turning depth, and then move longitudinally, the turning cut being divided between six tools. After the turning tools have removed the scale at the points where the grooves are to be produced, the back arms of the machine rock in and bring twelve tools into operation to rough-turn the grooves and rough-face the ends of the drum, while the carriage tools complete the rough-turning. The drum is then transferred to the finishing machine, without being removed from the arbor, where finishing cuts are taken by tooling identical with that just described.

In the turret lathe operation, the drum is gripped in a three-jaw chuck at the headstock end, as shown in Fig. 4, and supported at the other end by a steadyrest which is mounted on a dovetail member attached to the ways of the bed. When the work is placed in the machine, the finish-faced left-hand end of the drum is brought tight against the jaws of the chuck by placing a block of wood between the free end of the drum and the turret and then feeding the turret by hand firmly against the block. The turret is locked in this position and the chuck jaws tightened on the drum. A dial indicator mounted on a steel bar laid across the ways of the bed as shown, is then applied against the drum and the latter revolved. While the drum is being rotated, it is tapped lightly with a lead hammer until it runs true within a few thousandths inch, as shown by the indicator.

After the drum revolves concentrically within the tolerance mentioned, a light cut only 0.004 or 0.005 inch deep is taken over the surface that is in contact with the steadyrest rolls. This cut, which is taken by means of a tool mounted in bar *G*, corrects any distortion that may have occurred in the drum up to this time. Slight distortion may result from the heavy cuts taken in the roughing automatic lathe, and from the pressure of the two chucks used on the arbor in the two automatic lathe operations, which must be sufficient to hold the drum from revolving on the chucks. As some of the inside diameters of the drum are held to close limits, it is safer to take this light cut on the surface in contact with the steadyrest rolls in the turret lathe operation, in order to insure that this surface will run true with the inside of the drum. It requires only two or three minutes to mount bar *G*. After the cut has been completed, the steadyrest rolls are adjusted, against the drum.

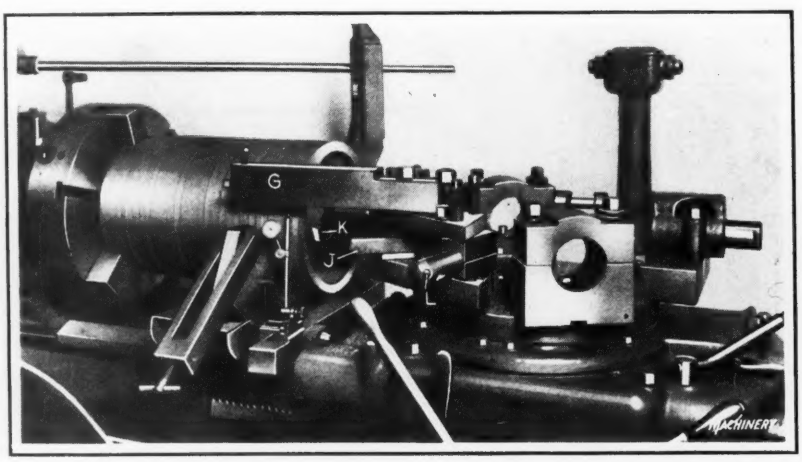


Fig. 4. Turning the Surface of the Drum that contacts with the Steadyrest Rolls, in order to make the Drum run True

All facing, boring, threading, or other cuts requiring the use of a cross-slide are accomplished in Jones & Lamson flat turret lathes by

means of the cross-sliding headstock, which may be moved forward or to the rear on cross-ways on the bed. Hence, when cross cuts are to be taken on work requiring a steadyrest, it is necessary to provide one that will slide crosswise with the headstock. The one used in the operation just described slides on the dovetail block previously mentioned. Gibs are provided on one side of the dovetail for adjusting purposes. To lock the steadyrest central with the headstock spindle, when the headstock is locked in the center of the bed, stop-pin H, Fig. 7, is simply dropped into a hole. When the pin is raised, the steadyrest is free to slide transversely with the headstock.

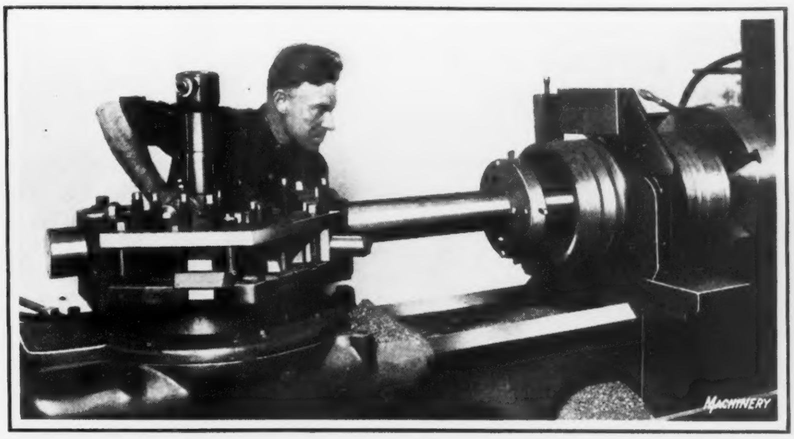


Fig. 5. Boring the Drum for the Full Length by employing a Piloted Head equipped with Four Cutters

Boring Operations in the Turret Lathe

The first step performed in the turret lathe consists of boring to size the left-hand end of the drum, as shown in Fig. 1, by employing tool J, Fig. 4. Then a supporting steel plate is fitted into this end to relieve the drum from the pressure of the chuck jaws in succeeding cuts. The drum is next reversed in the machine and clamped on the plugged end. Then, after the headstock has been placed in the center of the turret lathe by bringing it up against a stop, and the steadyrest has been centralized, a light cut of a few thousandths inch is taken on the surface of the drum that is now in contact with the steadyrest rolls. This cut is taken in the same manner as that on the opposite end.

When the drum has been made to run true in the steadyrest, the 10 3/4-inch diameter surface is bored the full length by means of the cutter-head shown in Fig. 5. This head carries four tools on a special long boring-bar which is piloted by a bushing in the headstock spindle and guided in special blocks on the turret. The turret blocks are made in two sections, the upper section being removed to permit the bar to be lowered in the bearings by an overhead crane. The bar is guided by hand into the spindle bushing, and the upper section of the blocks is then clamped in place. At the completion of the cut, the boring-bar is removed, to permit indexing the turret.

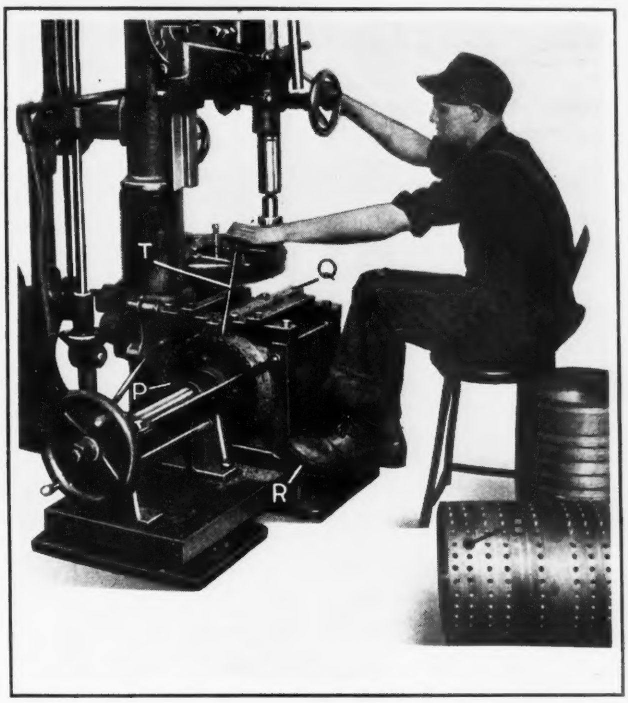


Fig. 6. Fixture used in drilling 396 Holes around the Drum

In the next position of the turret, the drum is finish-bored on the surface to be threaded and on the 10 3/4-inch diameter surface, tool K, Fig. 4, being used for both cuts. The stop-pin of the steadyrest is, of course, raised before this operation takes place. The diameters of the surfaces are controlled by using stops to limit the cross movements of the headstock, and the length of each cut is controlled by stops clamped between the ways of the bed to limit the longitudinal movements of the turret. Groove C, Fig. 1, which provides clearance for the thread in the right-hand end of the drum, is then cut with tool L, Fig. 4, after the turret has been indexed to the proper position. In this step, the head is fed crosswise the desired amount for cutting the groove, and then moved in the opposite direction to permit tool J to chamfer the end of the drum where the thread is to start.

The thread is cut by means of an automatic chasing attachment mounted at the sixth station of the turret, as shown in Fig. 7. In this step the only work on the part of the operator consists of feeding the headstock crosswise a slight amount each time that the tool completes a forward and return movement. The thread-cutting device consists of a ram M in which is mounted a thread chasing tool that is operated longitudinally by the lead-screw N. Power for driving this screw is delivered by the spindle through gearing and a shaft to rod O, which is geared to the lead-screw. As each forward movement of the ram is completed, it is returned with a quick motion, this cycle continuing automatically until the thread is finished. The operator feeds the work crosswise during the return movements of the ram. This attachment can be used for cutting external or internal threads of right- or left-hand

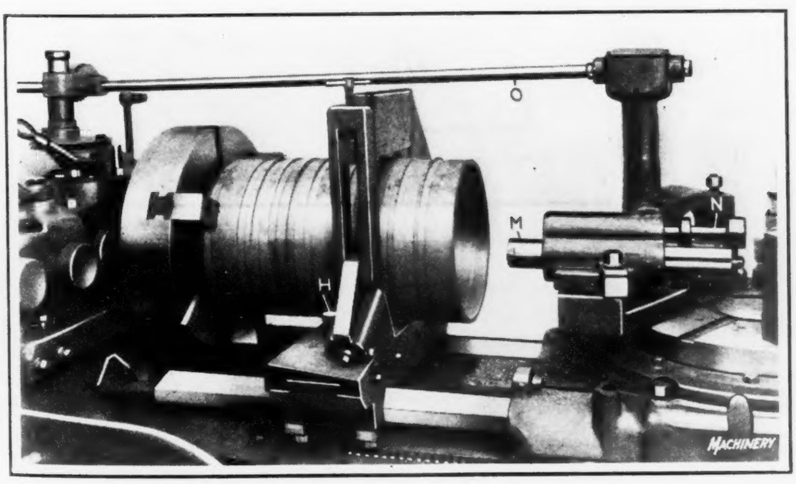


Fig. 7. Cutting an 11-inch Diameter Thread by Means of an Automatic Attachment

lead, and may be swiveled to permit cutting taper threads or grooves.

Cutting the threads in the same setting in which the other cuts are taken insures concentricity between the threaded and other machined surfaces. This is extremely important

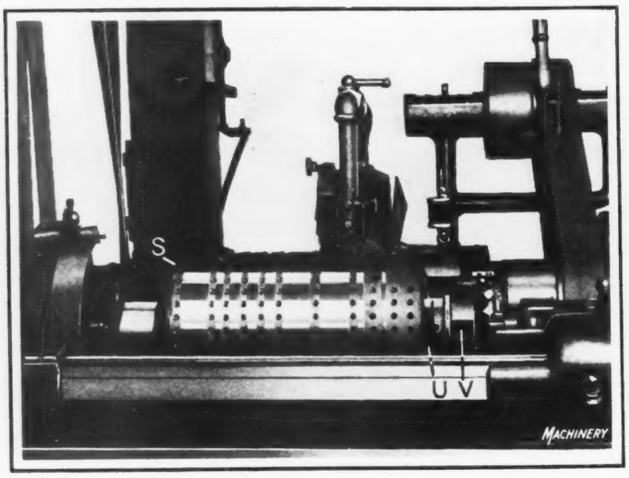


Fig. 8. Set-up of the Drum in the Cylindrical Grinding Machine for grinding the Outside Surface

in the sample of work being described. Also, by this method, errors due to a second handling are avoided.

Drilling and Grinding Operations

Hole *B* (Fig. 1) and the 395 small holes are drilled around the drum with the drum mounted in a special fixture, as shown in Fig. 6. The drum is seated in this fixture on a collar fastened to plate *P*, which has the periphery slotted to permit accurate indexing of the drum to suit the holes to be drilled. One finished end of the cam drum is brought up tight against the finished face of plate *P* by tightening a screw that runs through the drum into a bar placed against the other end of the drum. The large hole *B* is next drilled and reamed in the drum and then a plug is dropped through it into a corresponding hole in the collar to lock the drum firmly in place on the collar so that both can be revolved together in the fixture.

Bar *Q*, which runs the full length of the drum, is provided with bushings spaced to suit each axial row of holes to be drilled. In operation, a complete circle of holes is drilled around the drum by successively raising and lowering the drill through the first bushing in plate *Q*. While drilling each hole, plate *P* is locked to the fixture by means of foot-lever *R*, which has a tooth on it that engages the notches of the plate, but after a hole has been drilled, the foot-lever is depressed to withdraw the tooth from the notches of the plate and thus leave the drum free to be turned to the successive notch by means of handle *T*. After one circle of holes has been completely drilled, the drum and fixture together are moved to the left sufficiently to bring the second bushing in plate *Q* beneath the spindle of the drilling machine.

When all the holes have been drilled in the drum, the top of the fixture is removed and the holes are tapped. It is unnecessary to pilot the tap, and so the operation can be performed more quickly without the use of a bushing plate. The time consumed in drilling and tapping the holes averages 1 1/2 hours.

The final operation on the drum consists of grinding the outside diameter in a cylindrical grinding machine. As shown in Fig. 8, the drum is mounted on an arbor that has a flange *S* cast solid on one end. In placing the drum into the machine, the left-hand end is fitted on this flange. Another flange *U*, which is free to slide on the arbor, is screwed into the right-hand end of the drum by tightening nut *V*. These flanges locate the drum accurately on inside surfaces that have been machined within close limits. The grinding operation averages fifteen minutes, floor-to-floor time.

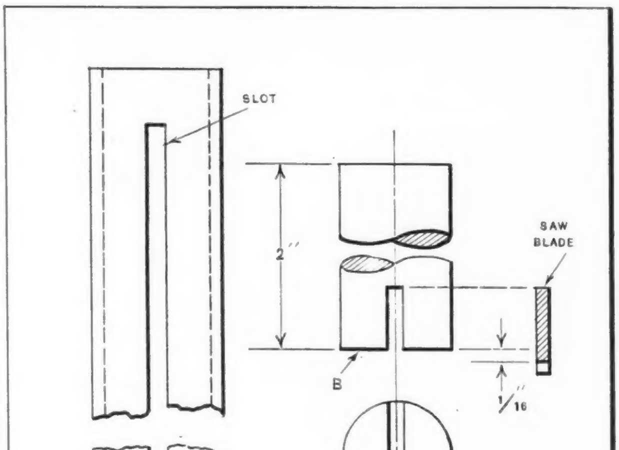
GUIDE FOR POWER HACKSAW BLADE

By JACOB H. SMIT

It is difficult to cut a piece of material off straight or square on an old power hacksaw when the top slide has become loose through wear. Excessive wear permits the saw blade frame to move to the right or to the left so that it cuts the stock at an angle. A looseness of only a few thousandths inch in the top slide allows the cutting edge of the blade to deviate considerably from a straight path. When cutting up stock on a hacksaw in this condition, the pieces must be made longer than would be the case if the hacksaw were in good condition. On pieces of large diameter this means that more time will be required to do the machine work and stock will be wasted.

On some large power hacksaws, a piece of tubing such as shown at *A* in the illustration is used as a guide for the hacksaw blade. A slot is cut in the tubing as shown, and the tube is fastened to the machine in an upright position so that the slot will guide the saw blade along a straight path at right angles with the axis of the stock. The saw teeth soon enlarge the slot, however, thus spoiling the tube as a means for guiding the saw blade. This difficulty may be overcome by fitting the tube with a plunger guide as shown at *B*. The slotted tube is removed and the hole reamed out or a new tube made. The plunger *B* is turned down from a piece of round tool steel to a sliding fit in the tube *A*. A slot is cut in one end of the guide plunger *B*. This slot is a sliding fit for the saw blade, and its depth is made equal to the width of the saw blade minus the height of the teeth plus 1/16 inch. Slots can be cut in both ends of the guide plug if desired, one slot being made narrower than the other to accommodate a thinner blade. The guide plug is hardened and drawn slightly after it is made.

In assembling the guide, the piece of tubing is first lined up square with the hacksaw vise. The guide *B* is then dropped into the tubing with the slotted end down so that

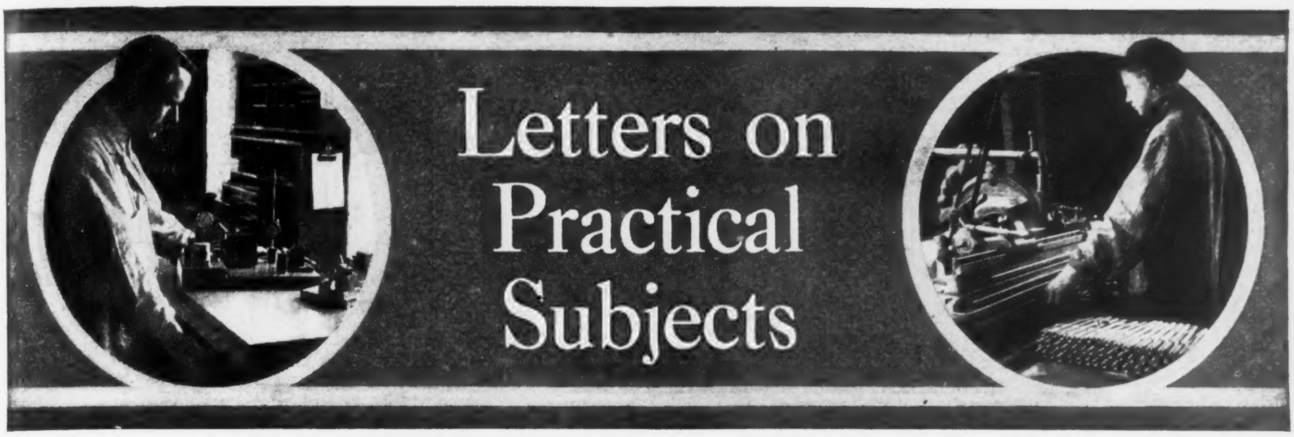


Tube and Slotted Plunger used to guide Hacksaw Blade

when the saw blade is inserted, the bottom of the slot will rest upon the back edge of the blade. As piece *B* is hardened and does not come in contact with the teeth of the saw blade, it will give good service for a long time without showing signs of wear.

* * *

According to the Department of Commerce, Cuba stood sixth in our export trade in 1924, being outranked only by the United Kingdom, Canada, Germany, France, and Japan.



ADJUSTABLE NOTCHING DIE

In Fig. 1 is shown a die designed for notching the edges of plates or long strips of steel like the piece shown by the heavy dot-and-dash lines at *S*. The tool equipment consists of a group of twelve punches *D*, Fig. 2, which enter the twelve shearing holes *A* in the die shown in Fig. 1. The strip of steel *S* may have one edge notched throughout its entire length of several feet. The notching is accomplished by punching out twelve notches at a time.

Referring to Fig. 1, the die-shoe *B* is grooved at *C* to receive a series of cutting blocks *D* and spacing blocks *E*. These blocks are clamped together by a tie-rod *F*. The sides of the cutting die are formed by blocks *D*, while a long bar *G* which has one edge ground with the proper clearance, forms the other cutting edge of the die. The entire group of blocks *D* and *E*, with the bar *G* held securely in groove *C*, combine to form a sectional die, the cutting portions of which are easily made and may be removed individually for replacement, should breakage occur.

The blocks are all clamped in place from the front side of the holder by a series of screws *H* which bear against bar *G*. They are clamped endwise against plate *J* by means of plate *M*, plate *J* being held by screws *L*. The die-shoe is made just long enough to permit clamping the blocks between the two end plates when using the filling or spacing blocks *N* and *P* at the ends. It will be noted that nut *Q* has a sleeve *R* on its front face which passes through plate *M*. This nut, in conjunction with tie-rod *F*, serves to clamp the sectional blocks together independently of the clamping action of the end plates.

The work *S* is placed in position under the overhanging stripper plate *T* against the back stop *U*. The back stop can be adjusted to vary the depth of the notches as required. When screws *V* are tightened, the plate *U* is clamped down firmly so that the stripper plate is held securely in position. The adjustment for the notch depth is accomplished by means of screws *W* held in blocks *X*, the operator merely adjusting the screws until the desired depth of notch is obtained. The stripper plate *T* is then clamped down by the screws *V*, thus making the die, the stripper, and the back gaging plate a substantial unit. The work is located endwise against the edge *Z* of the end-stop *Y*. This stop is all that is required when notching the sides of plates that have less than twelve notches.

When notching strips that have more than twelve notches, the first cut is taken with the end of the strip located against the edge *Z* of stop *Y*, following which the stop is

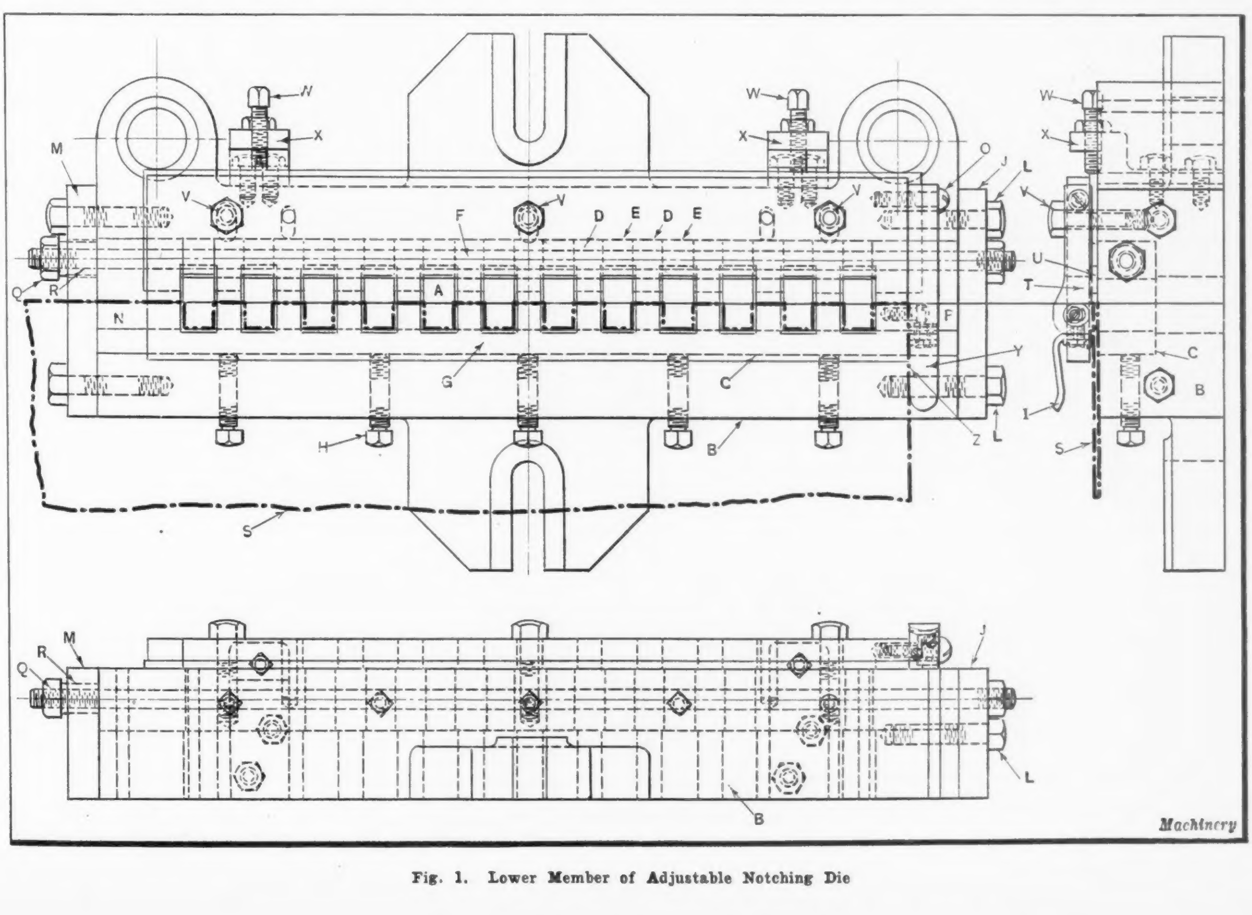


Fig. 1. Lower Member of Adjustable Notching Die

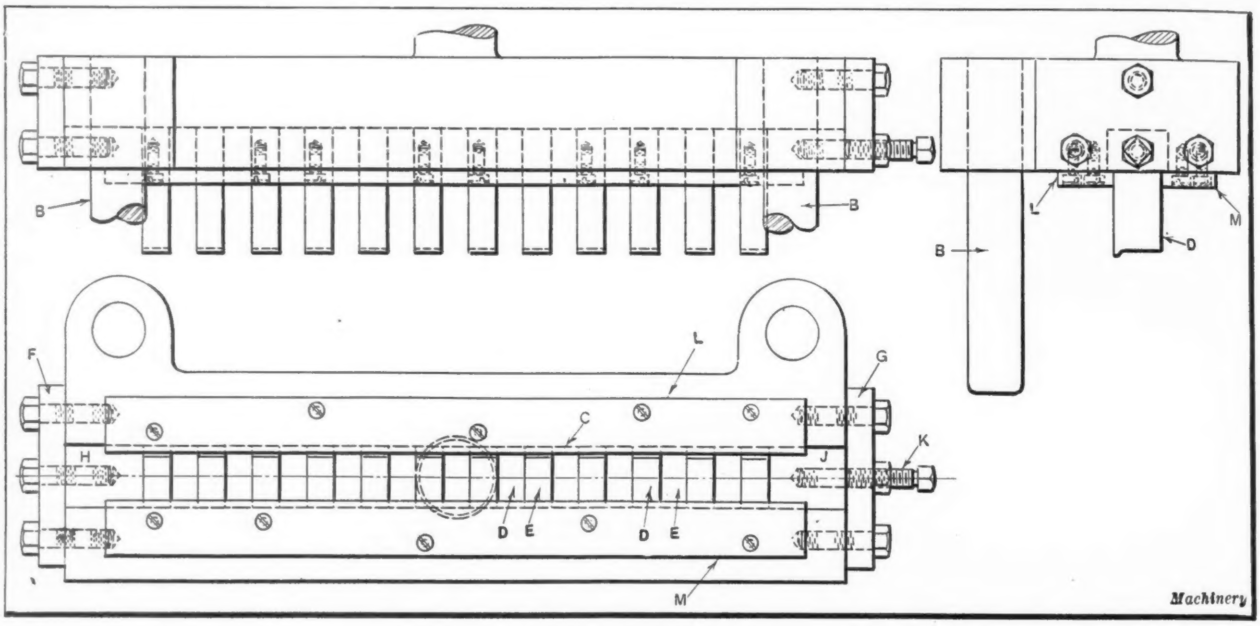


Fig. 2. Punch used with Die shown in Fig. 1

lifted by means of the finger grip *I*. so that the strip of steel can be passed under the stop. When the stop is lifted, it pivots on the screw shown at *O*. After the strip has been fed along until the last notch on the left is under the stop *Y*. the latter member is allowed to drop down and enter the notch, thereby locating the work for the next series of notches. Then the punches again descend and make another cut, after which the same operations are repeated until one side of the piece is notched for its full length.

The body or holder of the punch member (see Fig. 2) is grooved to receive the punches *D*, which in combination with a series of spacing blocks *E* form the notching punch. The punches and spacing blocks are clamped between plates *F* and *G* by screw *K* which tightens block *J* against the punch-block at the right-hand end of the holder. The two plates *L* and *M* form a channel which, in combination with groove *C*. serves to support the punches in the holder. One of the advantages gained by constructing a die in the manner described is that the various units can be ground to size, which permits replacements to be easily made. S. SERVER

CARE AND USE OF ERASERS

It has been said that one of the most important tools in a draftsman's kit is the eraser; hence a few suggestions on using erasers should not be out of place. As it is desirable that the eraser have a sharp or narrow edge for erasing fine lines, it is a good practice to hold it at an angle of about 15 degrees with the paper when erasing broad lines, using each side alternately. The writer avoids using the erasing shield whenever possible, and he believes it is better to erase a small section of the drawing and redraw the correct lines. The eraser should always be used as carefully as possible, in order to avoid roughing up the surface of the paper; otherwise it will have a tendency to gather dirt.

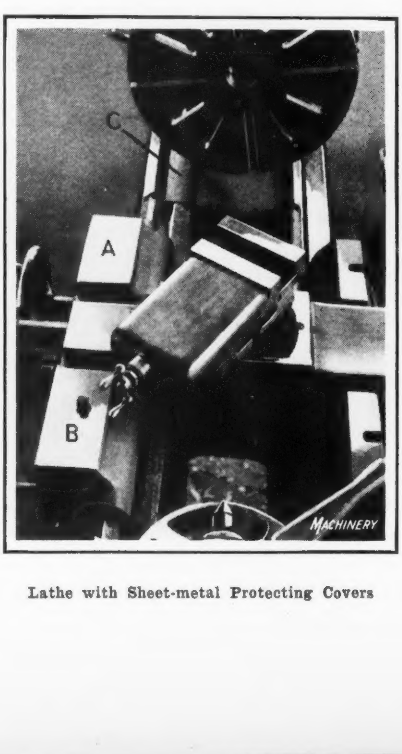
A so-called "ink eraser" should never be used on tracing cloth. It takes a little longer to erase an ink line with a soft eraser, but the surface is left smoother and will take the ink again readily. Art gum is valuable only as a means of cleaning an ink drawing. If it is rubbed over a pencil drawing, it will remove some of the lines. A drawing that has been cleaned with art gum will also become soiled quickly. It should be remembered that tracings can be cleaned with a cloth moistened in gasoline. Banana oil can be used to good advantage in removing pencil lines from vellum. When an eraser becomes hard or smudges the drawing, it can be restored to good working condition by rubbing it vigorously on a clean piece of drawing paper.

Cleveland, Ohio HERBERT W. CABLE

PROTECTING LATHES FROM DAMAGE

The machinist who does fine work knows how important it is to keep his machine and tools in the best possible condition, and he generally takes pride in the appearance of his machine as well as in the quality of his work. Such men dislike to see a fine machine tool abused and do not like to use a machine that shows signs of rough treatment. Certain parts of the machine are bound to be worn more or less, however, even with the best of care. This can only be avoided by protecting such parts with guards.

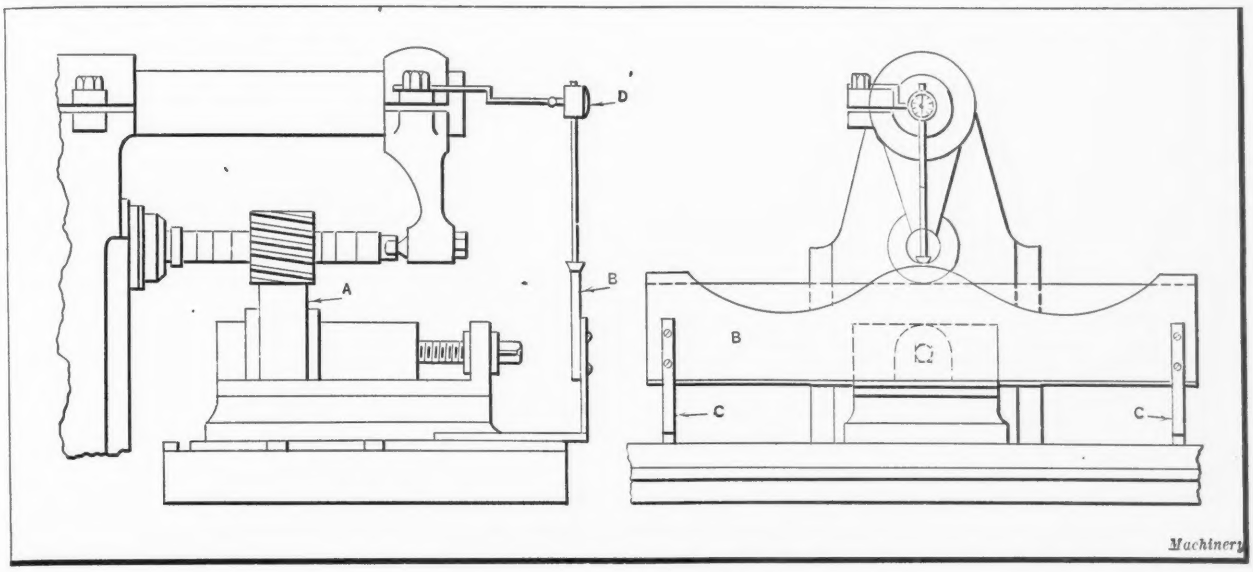
The surfaces on a lathe that most often show wear or abuse are the ways near the head where the chuck and faceplate are allowed to drop down when they are removed from the spindle, and the top of the carriage, on which the workman often drops or lays tools. These surfaces may be protected by sheet-steel slips or covers. The sheet-steel covers *A* and *B* on top of the lathe carriage shown in the accompanying illustration are held in place by screws threaded into blocks that fit the T-slots. The edges of these metal pieces are bent over to give them a neat appearance and keep them in place. If it is necessary to use T-slots, the pieces can be removed temporarily.



Lathe with Sheet-metal Protecting Covers

Some machinists exercise but little care in laying files and wrenches on finished surfaces. However, surfaces protected by guards like those shown cannot be injured in this way. The guard shown at *C* is made from a piece of sheet steel, 1/16 inch thick, and is creased or bent to fit over the lathe ways. This guard prevents the ways from being scored when the heavy chuck or faceplate is dropped down, and it also prevents the chuck or faceplate from being dropped between the way.

Middletown, N. Y. DONALD HAMPSON



Method of using Templet and Indicator in Profile Milling

PROFILE-MILLING A FORMING DIE

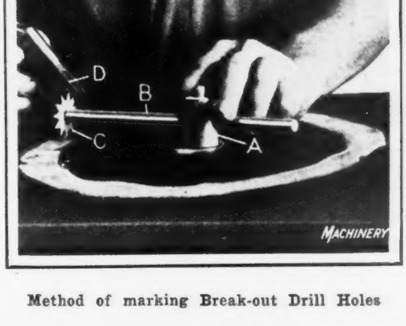
As the method employed in machining certain forming dies on a shaper consumed too much time, it was decided to equip a milling machine for the work. An end view of one of the dies is shown at *A* in the accompanying illustration. At *B* is shown a templet having the same profile that is to be milled on die *A*, which is to be used for forming an automobile part. With the old method, the profile of such dies was roughed out on the shaper and then filed smooth. With the new method described in the following, no hand filing or finishing is necessary.

After securing the templet *B* in place by means of brackets *C*, the dial indicator *D*, equipped with an extension stem, was secured to the over-arm of the milling machine in such a position that the end of the indicator stem made contact with the profile surface or edge of templet *B*. When the work is clamped in place, the operator starts the table feed, and by means of the handwheel that controls the vertical feed raises or lowers the table as it advances in such a manner that the hand on the indicator *D* is kept on the zero mark. This results in milling a profile on the work that is a duplicate of that on the templet. A fine table feed was used at first, but after the operator had obtained a little practice in controlling the up and down movement of the table, a coarser feed was employed. If a dial indicator is not available, a lever arm type of indicator made from sheet metal can be made to serve the purpose satisfactory.

Philadelphia, Pa. CHARLES KUGLER

MARKING BREAK-OUT DRILL HOLES

The usual small-shop method of cutting out large holes in boiler plate is to drill a series of small holes spaced close together on a circle having a diameter slightly smaller than the required opening and then break through the spaces left between the holes with a chisel. In the accompanying illustration is shown a tool for marking or locating the centers of the holes for work of this kind. Although the spacing of the holes need not be exact, it must be fairly uniform. If the spacing is done carelessly, some of the holes may be so close together that the drill will run off center and be broken. On the other hand, if the holes are spaced too far apart, too much time will be required in breaking out the metal between them.



Method of marking Break-out Drill Holes

The tool shown in the illustration consists essentially of three parts, a central arbor *A* made from a piece of round stock, with a small conical center turned on the bottom end, a slide bar *B*, which is a sliding fit in the hole in piece *A*, and a spiked wheel *C* made from sheet metal, which rotates on a screw at the end of the slide bar. The teeth of wheel *C* are spaced in this case to give a distance between the centers of the holes of 3/8 inch.

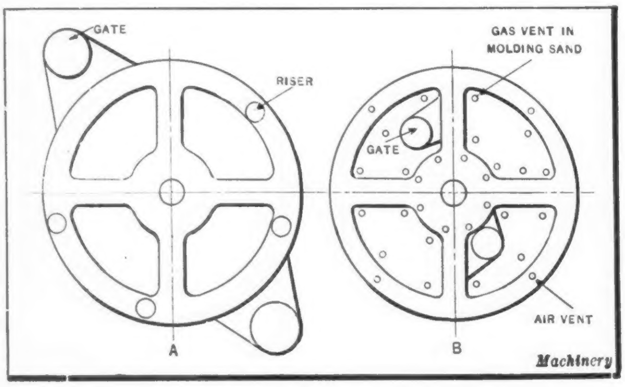
In using the marking device, the center of the required hole or opening is located, and a deep center-punch mark made at this point. The slide bar of the tool is then set to bring the spiked wheel the correct distance from the center of the conical locating point on the bottom end of *A*. Next the projecting conical point in this member is placed in the center-punch mark, and the tool revolved slowly with one hand while the small brush *D*, dipped in Prussian blue is held over the wheel with the other hand, as shown in the illustration. If the work is well chalked, the teeth of the wheel will plainly mark the spots to be center-punched.

Rosemount, Montreal, Canada HARRY W. MOORE

MOLDING CAST-IRON WHEELS

The strength of a cast-iron wheel depends a great deal on the construction of the mold in which it is cast. Some years ago a certain manufacturer had trouble with some cast-iron flywheels. If one of the wheels was chucked and turned in the afternoon and left on the lathe over night, it would be found to be out of true or badly warped the next morning. It was thought at first that the method of chucking the wheel was responsible for the trouble, but after being assembled on the machines, the wheels would often continue to warp so that it was necessary to discard them. Wheels that were trued up on the shaft of the machine would again run out of true after a short time. In some cases, the spokes cracked while the wheels were standing idle. The danger of having a spoke crack or break when a wheel was in use made it necessary to take steps to correct the trouble.

The foundryman, on being convinced that the machining operations were not at fault, changed the gating in the mold. The wheels that gave trouble were all cast in a mold like the one shown at *A* in the illustration. A gate was located on each side of the rim, and there were several risers on the outside of the wheel. The metal was poured from two ladles simultaneously. At *B* is shown the method of arranging the gates to overcome the warping and cracking of the spokes. With the latter method, one gate is placed close to the



Unsatisfactory and Improved Methods of gating Molds

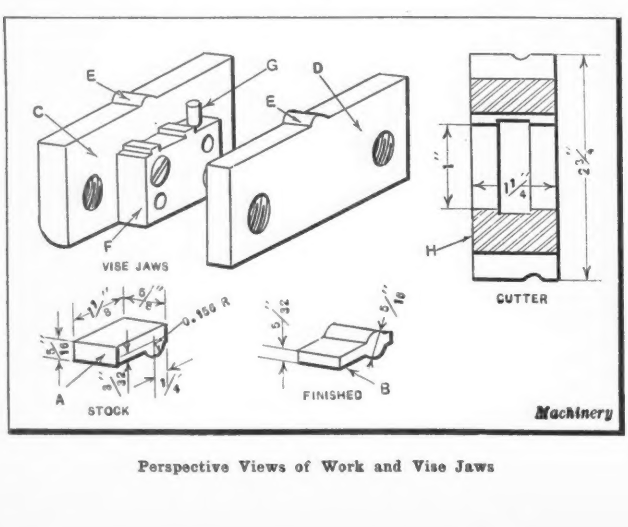
hub, and feeds the hub as well as the rim through one of the spokes. The other gate, placed on the opposite side of the hub, feeds the rim through a spoke. Both the gates were provided with generously proportioned risers. While making the mold, several large nails or rods were placed in the sand. These nails were removed after completing the mold, thus leaving air vents. The two gates of the mold shown at *B* were poured simultaneously.

By gating the mold as shown at *B* the hub was the last part of the casting to cool off or solidify. The rim while cooling would shrink, thereby contracting the spokes instead of pulling them apart as was the case when the mold was gated as shown in the view at *A*. After machining the flywheels produced from molds like the one shown at *B*, very little warping occurred, and it required five or six heavy blows to break or fracture one of the spokes, whereas the spoke of a wheel cast by the old method of molding would usually break at the first blow. With the new method of molding, the iron was more dense and the diameter of the casting was somewhat smaller than when the old method was used, even though the same pattern was employed. Much better results were obtained by removing the top flask from the mold and breaking the sand as soon as the casting became somewhat solid. The sand was not removed, however, until the casting cooled off.

Newark, N. J. JACOB H. SMIT

PERSPECTIVE DRAWINGS FOR SPECIAL VISE JAWS

Perspective drawings or sketches can often be used to advantage when the object is simply to convey to the toolmaker the general idea of the construction desired, and it is permissible to allow him to work out the actual details from a drawing or a sample of the part to be produced. A good example of this type of drawing is shown in the upper left-hand corner of the accompanying illustration. The work is shown at *A* and *B*, and the formed milling cutter in the section view at *H*. The work is held between the vise jaws *C* and *D* on a milling machine, while the formed cutter *H*



Perspective Views of Work and Vise Jaws

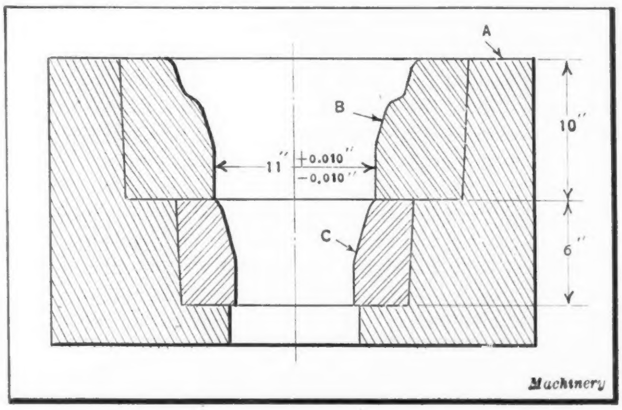
is employed to mill first one side, as indicated at *A*, and then the opposite side. The piece finished in this manner is shown at *B*.

The jaw *C* is attached to the fixed member of the vise, while the jaw *D* is attached to the adjustable member. On the top of each jaw is a projection *E* which conforms with the shape of the milled work, and holds it more firmly in place. The block *F* is permanently attached to jaw *C* and serves as a locating seat for the work, which is positioned endwise by the pin *G*. Perspective views like the one shown, while they readily convey the idea of the desired construction to the mechanic, are not extensively used in tool design, as it is difficult to dimension them properly.

Holyoke, Mass. FRANK H. MAYOH

GRINDING AND POLISHING A DEEP DRAWING DIE

The following data, covering methods that were successfully employed in grinding and polishing the top ring in the deep drawing die shown in the accompanying illustration, may be of interest to others who encounter similar grinding jobs. The die, which consists of the draw-rings *B* and *C* mounted in the holder *A*, is used with a double-acting punch for drawing deep shells from 16-gage sheet metal. The allowable variation in the dimensions of the ring *B* is



Deep Drawing Die with Ground and Polished Rings

plus or minus 0.010 inch, while the bottom ring *C* is held within limits of plus or minus 0.001 inch. In grinding the top ring, a Norton 36-grain grade M wheel is used for the rough-grinding operation, and a 60-grain grade K wheel for the finish-grinding, after which a felt buffing wheel charged with 80-grain abrasive is used for polishing.

For the grinding operations on this work, a wheel diameter of about 8 inches was found to give a suitable contact surface. The width of the grinding wheel was 1 inch, and the feed about 5/8 inch per revolution of the work. The speed of the work was approximately 74 revolutions per minute. This speed gave the wheel, which was run at a speed of 2000 revolutions per minute, ample time to remove the stock as fast as it was presented to it. About 0.040 inch of stock was removed, and the time required for the complete grinding and finishing operation was about eighteen hours. CLAYTON WHEELER

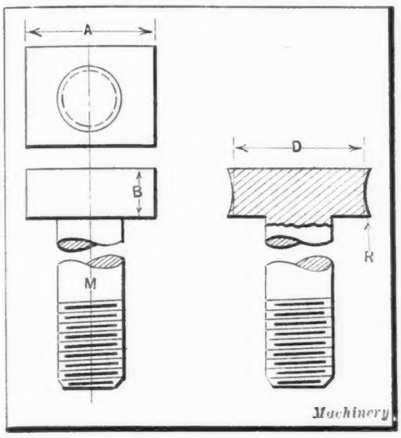
* * *

The work involved in bringing about national uniformity in the use of colors for traffic signals is nearing its completion; full agreement has been reached upon the various technical details, and the code is about to be published, according to an announcement of the American Engineering Standards Committee. The code covers the use of luminous and non-luminous signs and signals in connection with highway traffic, including moving and flashing signals; and the use of lights, semaphores, and other signaling devices on vehicles. The three colors agreed upon for primary traffic control signals are: red, for stop; yellow, for caution; and green, to proceed.

Shop and Drafting-room Kinks

RECLAIMING COPPER BOLTS

A large order of copper bolts like the one shown at *M* was rejected because the dimension *A* was 1/32 inch under size. On investigation, it was found that the dimension *B* could be made somewhat smaller than specified on the original drawing. This permitted the head to be increased in width by subjecting the bolt to a squeezing operation in a geared punch press. After this operation, the head appeared as shown at *R*. The correct width *D* was then obtained by milling the sides of the bolt head. The thickness *B* was decreased such a small amount by the squeezing operation that the change was hardly noticeable, and there was no perceptible change in the diameter of the bolt.



Bolt before and after Squeezing Process

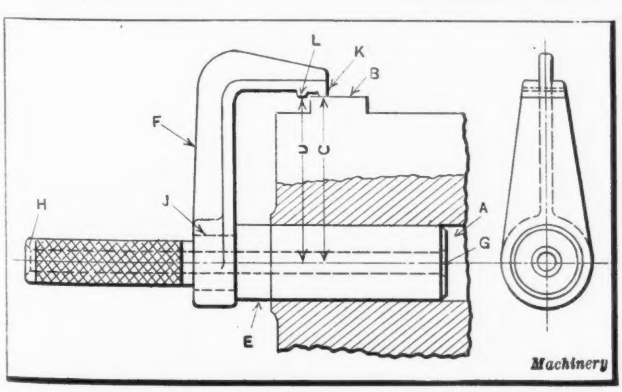
Philadelphia, Pa. CHARLES KUGLER

GAGING DISTANCE FROM HOLE TO FINISHED SURFACE

The gage shown in the accompanying illustration is used for gaging the height *C* from the center of the hole *A* to the finished surface *B*. When surface *B* is finished, the height *C* from the center of the hole previously bored to surface *B* must be exact. This is a limit gage, or what is known among shop men as a "Go" and "Not Go" gage. In this design, the "Go" dimension is the height *C* and the "Not Go" distance is the height *D*.

The gage is of simple design, consisting of only two parts, the cylindrical plug *E* and the arm *F*. The plug is made of machine steel, and is pack-hardened and ground. Both centers *G* and *H* are carefully lapped before the plug is ground. The plug is then pressed into arm *F* at *J*. The arm is made of machine steel and is shaped by forging. It is then pack-hardened and ground at *K* and *L*. In order to give proper rigidity to the arm, a rib is provided. The cross-section of the arm thus formed resembles the letter T. This design tends to prevent springing. The small end of the plug is knurled to give the gage proper feel and to facilitate handling.

Brooklyn, N. Y. FREDERICK W. MING

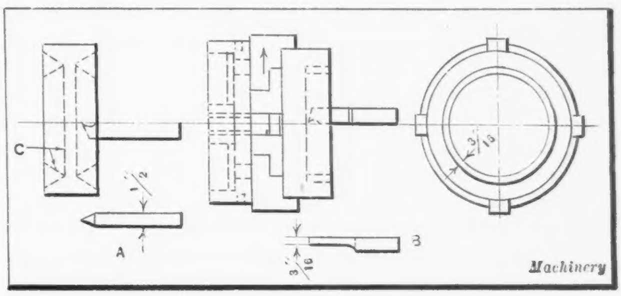


Gage for gaging Distance from Center of Hole to Finished Surface

CUTTING BLANKS FOR BEARING RACES

While in the employ of a ball bearing manufacturing company, the writer often found it necessary to cut out blanks for ball bearing races that ranged in size from 4 to 5 inches wide by 12 to 16 inches in diameter. About three hours was required to cut out rings of this kind. First a roughing cut was taken with a tool like the one shown at *A*, the point of the tool being gradually fed in until an annular groove, 1 1/2 inches wide at the outside, as indicated at *C*, was produced. The stock was then reversed in the chuck, and a similar groove turned on the opposite face. The depth of the latter groove was gradually increased until the ring was finally severed from the stock. This method of cutting the rings from blank pieces required considerable time and wasted a great deal of metal.

In order to save time and material, the writer adopted the following method of cutting the blanks from the cylindrical stock. First the lathe belt was reversed so the cutting pressure of the tool was exerted in a downward direction. Instead of the V-pointed tool a narrow square-pointed tool 3/16 inch wide was used, as shown in the illustration at *B*. A very fine feed was employed, and the blank cut off by taking a cut on each side of the stock the same as in the old method. With the new method, the blank could be cut from the stock in about one-third the time formerly required.



Methods of cutting Bearing Races from Solid Stock

Bronx, N. Y. D. H. SINGER

* * *

THE SMALL TOOL INDUSTRY IN GERMANY

A recent issue of *German Trade Reports and Opportunities* mentions that the uncertain situation that marked the beginning of the year has been replaced by a more hopeful outlook. There has been a good demand in the German domestic market for reamers and other cutting tools. In order to put the tool industry on a firmer basis, a syndicate has been formed comprising, so far, more than fifty firms making small tools. A price-fixing policy will be adhered to by this syndicate. The present demand for small tools is especially from concerns building bridges and doing other construction work, and from firms engaged in boiler-making, and in railway-building. High-speed steel tools are being used more and more. The industry is operating at about 75 per cent of its pre-war activity. The export trade leaves much to be desired, but the demand from South America, the Far East, Spain, and Italy has improved. England offers the keenest competition, it is stated.

* * *

The American Society for Testing Materials intends to establish an annual medal known as the Dudley Medal, which will be awarded to the author or authors of a paper of outstanding merit presented before the society and constituting an original contribution in research on materials.

Questions and Answers

COMPRESSED AIR FOR GAS FURNACES

D. M.—Can compressed air be used advantageously for a gas furnace or for a furnace using oil as a fuel? Ordinarily, about 16 ounces of pressure is used for a gas furnace, while air in an ordinary compressed air line might have from 80 to 100 pounds pressure. Has the injector principle ever been used, by which a small volume of compressed air under high pressure will draw in sufficient air under atmospheric pressure to bring the total pressure down to about 16 ounces?

IRON AND STEEL INDUSTRY

J. A. R.—Information is desired regarding the number of plants in different important branches of the iron and steel industries, as well as the total number of wage earners in each case, or any other data tending to show the relative importance of each industry. Have such figures ever been compiled?

A.—Data of the kind referred to have been compiled by the Bureau of the Census of the Department of Commerce. The following information relating to the iron and steel industries in the United States is a very small part of the Biennial Census of Manufactures for 1923. The group of industries represented covers the manufacture of various important products.

Machine Tools—Number of establishments engaged in machine tool manufacture, 350; average number of wage earners (not including salaried officers, employes, or firm members), 33,277; total value of products, $136,871,096. Of this amount Ohio led with a production amounting to 26.6 per cent of the total; Pennsylvania was second with 9.3 per cent; Massachussetts third with 9 per cent; Connecticut fourth with 8.4 per cent; Illinois fifth with 8.3 per cent; Rhode Island sixth with 7.6 per cent; and New York seventh with 7.4 per cent.

Foundry and Machine Shop Products—This classification includes only those foundries and machine shops that make such a large variety of products that they cannot properly be assigned to a specific industry. Hence, it does not include foundries and machine shops connected with specific industries, such, for example, as the agricultural, automotive, electrical, textile machinery, locomotive, or machine tool industry.

Number of establishments not assigned to specific industries, 8532; average number of wage earners, 449,040; total value of products, $2,337,807,997.

Motor Vehicles—The following figures apply to manufacturers whose principal products are assembled motor vehicles, and do not include establishments engaged primarily in the manufacture of bodies, parts, or accessories.

Number of establishments, 351; average number of wage earners, 241,356; total value of products, $3,163,327,874. The total number of gasoline or steam-driven passenger vehicles was 3,472,420. The proportion of closed passenger cars increased from 10 per cent in 1919 to 21.6 per cent in 1921, and to 35.1 per cent in 1923. The total number of public conveyances including motor buses, cabs, etc., was 12,878.

Of the 351 establishments, 54 were in Michigan; 46 in Ohio; 32 in Illinois; 30 in Indiana; 30 in New York; 28 in California; 26 in Pennsylvania; 20 in Wisconsin; and 14 in Massachusetts.

Locomotives—The following figures apply to establishments engaged primarily in the manufacture of locomotives.

Number of establishments, 19; average number of wage earners, 30,672; number of steam locomotives constructed, 3422; total value, $177,891,022.

Steam and Electric Railroad Cars—Number of establishments engaged primarily in the manufacture of such cars, 130; average number of wage earners, 76,438; total value of products, $574,521,279.

Motorcycles—Number of establishments, 13; average number of wage earners, 3437; total value of products, $15,508,802; number of motorcycles constructed, 41,894.

Bicycles—Number of establishments, 25; average number of wage earners, 3122; total value of products, $16,708,207; number of bicycles constructed, 480,077.

Aircraft—Number of establishments, 33; average number of wage earners, 2901; total value of products, $12,945,263; number of airplanes, 505; number of seaplanes and flying boats, 82.

Electrical Machinery, Apparatus, and Supplies—Number of establishments, 1671; average number of wage earners, 234,892; total value of products, $1,293,001,751.

Textile Machinery—Number of establishments, 428; average number of wage earners, 35,672; total value of products, $140,661,358. This classification covers all kinds of textile machinery, including bleaching, dyeing, printing, mercerizing, finishing, etc. Of the 428 establishments, 137 are located in Massachusetts, 70 in Pennsylvania, 56 in New Jersey, 51 in Rhode Island, and 24 in New York.

Engines and Water-wheels—The following figures apply to establishments, the principal products of which are steam engines (other than locomotives), turbines, internal combustion engines (except those made by motor vehicle and motorcycle manufacturers), traction engines, etc. Number of establishments, 249; average number of wage earners, 48,495; total value of products, $266,997,778.

Pumps—The following figures apply to establishments engaged primarily in the manufacture of hand pumps, steam pumps, and other power pumps. Number of establishments, 229; average number of wage earners, 14,550; total value of products, $92,928,327.

Pig Iron—Number of establishments, 169; average number of wage earners, 36,712; total value of products, $1,007,613,340. Of the 169 establishments, 53 were in Pennsylvania; 38 in Ohio, 17 in Alabama, and 11 in Michigan.

Iron and Steel Forgings—These figures apply to establishments engaged primarily in the manufacture of iron and steel forgings. Number of establishments, 233; average number of wage earners, 27,409; total value of products, $178,951,349. Forty-eight establishments were located in Pennsylvania, 36 in Ohio, 27 in Illinois, 25 in New York, 18 in Connecticut, and 18 in Michigan.

Steel Works and Rolling Mills—Number of establishments, 489; average number of wage earners, 388,201; total value of products, $3,154,324,671. Of these establishments 186 were located in Pennsylvania, 81 in Ohio, 31 in New York, 30 in Illinois, 25 in Indiana, 19 in New Jersey, and 17 in West Virginia.

Copper Smelting and Refining—Number of establishments, 30; average number of wage earners, 20,735; total value of products, $567,984,807. Of these establishments 9 were located in Arizona, 4 in New Jersey, and 3 in Montana.

Lead Smelting and Refining—Number of establishments, 20; average number of wage earners, 6194; total value of products, $227,735,149.

Zinc Smelting and Refining—Number of establishments, 35; average number of wage earners, 11,918; total value of products, $94,183,900. Of these establishments 9 were located in Oklahoma, 8 in Illinois, and 3 each in Arkansas, Kansas, Pennsylvania, and West Virginia.

RAILROAD APPRENTICESHIPS IN A NATIONAL TRAINING PLAN*

By F. W. THOMAS, Supervisor of Apprentices,
Atchison, Topeka & Santa Fe Railway Co., Topeka, Kansas

Some efforts were made, during the control of the railroads by the federal government to require all railroads to establish a modern method of training apprentices. Not much was accomplished, but there is no doubt that a standard and uniform method could be evolved for the training of apprentices by the railroads if the methods were sufficiently flexible to suit the peculiarities of the various railroads.

While the general plan would be applicable to manufacturing plants, the latter do not require as high grade mechanics as the railroads, for, on account of the preponderance of duplication prevalent in manufacturing plants, they are more concerned in securing a specialist, a man who is adept at one operation, while the railroad shop or roundhouse mechanic may in a day engage in a dozen entirely different operations, each requiring a complete knowledge and skill. A production plant wants a man who can successfully operate a lathe, turning out the same product day after day; but in a railroad repair shop this man must be equally proficient in turning, boring, chucking, or facing, or even in converting the lathe into a milling machine, and must be able to run a planer, a slotter, or perform erecting or floor work with equal proficiency.

The training of apprentices on the Santa Fe Railway has become such a fixture from long usage as to remove it from the experimental stage. It is as much a part of our shops as our power house or our tool-room. No shop can operate without power to drive its machinery or lights to illuminate its buildings, nor can it operate without some department to make or maintain tools, jigs, or devices, for the machines and men. Neither can a plant be operated without men. The introduction of more complicated machinery and devices makes it the more imperative to have a trained hand and brain to operate them successfully.

From what source can the necessary skilled hands be recruited to obtain from these highly complicated, high-priced machines, a commensurate output? Recruiting may not be so difficult with the so-called production plants, where a workman becomes an automaton, producing a part, or performing one operation on a part, day after day, but in a railway shop or repair shop, a mechanic must be a mechanic in every sense.

For several years prior to 1907 the Santa Fe Railway was in straits continuously for skilled men. So we began that year in a small way to inaugurate our present apprentice system, spreading out gradually to all mechanical points from Chicago to the Golden Gate, from Denver to the Gulf of Mexico. We began to enjoy its benefits at once.

The Santa Fe system takes boys between 16 and 22, good, healthy, alert boys who really want to learn a trade. A personal interview is required. The boy must have a grammar school or preferably a high school education. He must pass a medical examination before a company surgeon. He must indenture himself with the consent and signed approval of his parents or guardian. The signature of the master mechanic, or superintendent of shops, makes the contract. The contract finally goes to the supervisor of apprentices for his personal signature and to see that all the requirements are complied with. This completes the preliminaries.

The boy now goes in the shop to begin his course of training, a regularly designated apprentice-shop instructor taking him in hand. He is given a locker, tool checks, and a time card. He then begins his regular, productive, useful work. A schedule of work is made for each shop, suitable for the local conditions. Every machine, bench, or floor job carries its assignment. The work in this schedule may not come in rotation or in natural sequence, but the boy will get his allotted time on each. Changes of work are left entirely to the instructor, for he is solely responsible for the boy's training. At the end of his indentured time, the boy, if he is a boilermaker apprentice, will know a boiler from the ashpan to the smokestack, know each part by its correct name and its functions, know how to lay out each sheet, develop it, roll up, rivet, and weld it, stay it, test it, and will be familiar with all the company and federal rules governing the manufacture and maintenance of boilers. In fact, he will be a real boilermaker. So also is it with machinists, blacksmiths, car men, patternmakers, pipe fitters, etc.

At each of the mechanical shops of the railroad (43 in number) mechanical and free-hand drawing, shop mathematics, company and federal rules pertaining to the trade, federal and state laws of the trade, standard shop practices, and other subjects supplementary to the practical shop features are taught. The railroad company provides the schoolroom, located in the midst of the shop buildings, equipped and dedicated to the apprentices. Drawing instruments, models, textbooks, stationery, etc., are furnished free, and an instructor, theoretically and practically skilled and trained, presides over this school-room. The apprentice is required to attend a two-hour session, two days each week, 208 hours per year, or 832 hours for his four-year apprenticeship, and is paid his regular shop rate of pay while attending.

Regular apprentices serve four years or eight periods of 1160 hours each, a total of 9280 hours. Helper apprentices serve three years or 6960 hours. Special car men apprentices serve three years or 6960 hours. The rate of pay varies according to trades and class of apprentices. Regular four-year apprentices begin at 31 cents per hour, car men at 44 cents per hour, and special apprentices at 57 cents, and each receives an increase of 2 1/2 cents per hour every six months. Apprentices must have a standard set of tools for their trade. These are purchased through the company at wholesale prices and the apprentice pays for them in small monthly payments. The company provides a tool-box free of charge.

One difficult feature in the early days of the present system was getting a fair and impartial estimate of the boy. A board to pass upon each apprentice each month during his probationary period of the first six months, and every six months afterward or as often as individual cases demand, was established. This board is composed of general foremen, department and gang foremen, and the shop and school instructors. They pass on the fitness of the boy to continue his apprenticeship, recommend discipline, suggest means to improve any weakness that may be evident, and advertise the strong, aggressive, industrious boys, especially emphasizing qualities of leadership that may be evident. This is wonderfully helpful in training and developing a young boy.

What has the railroad received in return for all the labor and expenditure in training these boys? Ten years after starting, it trained all the mechanics needed. The Topeka shops—the largest in the system—up to the time of the war, had not employed a mechanic from the outside for more than two years. Think of a railroad shop employing 3000 men, making all its own skilled mechanics—men familiar with the shops, methods, standards and practices.

From the ranks of the graduate apprentices are recruited draftsmen, assistants in the test department, and assistants for staff duties. The following list shows what becomes of some apprentices:

Division master mechanics	7
Division and general foremen	23
Roundhouse foremen	16
Assistant roundhouse and roundhouse gang foremen	63
Machine and erecting foremen	38
Boiler foremen	18
Car foremen	6
Miscellaneous foremen	7
Miscellaneous positions	16
Apprentice instructors	46
Total	240

*Abstract of a paper presented before the spring meeting of the American Society of Mechanical Engineers, at Milwaukee, Wis.

COOPERATION BETWEEN VOCATIONAL SCHOOLS AND INDUSTRY

In an address before the American Society of Mechanical Engineers in Milwaukee, R. L. Cooley, director of vocational education of the city of Milwaukee, referred to the need of more cooperation between the public educational activities and the industries that employ young people. In referring to this need, Mr. Cooley stated that in Milwaukee there are about 90,000 young people in elementary and parochial schools, both public and private, and approximately 10,000 in the high school, excluding the technical high school, the trade schools, and the full-time schools. There are 39,000 other young people between the ages of fourteen and twenty who are either in some form of employment or idle, but they are all in the formative years of their lives when the sort of development they undergo will determine to what economic or social plane they will attain.

Milwaukee is approaching the apprenticeship problem by the method of part time in trade, commerce, or industry, and part time in vocational school during the formative period of life. We are living in a world in which training and intelligence are needed more and more. There is a greater need for apprenticeship because of the inadequacy of the full-time school.

In Milwaukee all young people over fourteen years of age who have completed the eighth grade, or who have spent nine years in an effort to complete it, are permitted to enter employment on half-time until they reach the age of sixteen. After sixteen years of age they may continue in employment until eighteen, attending school eight hours a week. After reaching the age of sixteen they may enter a legal apprenticeship, attending school during the daytime four hours per week for the first two years of the contract.

When a trade school was opened in the city of Milwaukee, offering four-year courses, attendance was limited by the fact that the majority of those young people aspiring to service in the trade could not afford to attend, but had to enter immediately upon earning money, and further by the fact that the trade school could offer but few courses, thus lacking the variety of opportunity necessary to meet the needs.

A trade school for eight or nine trades is hopelessly inadequate for a community which needs workers trained in a hundred different lines. What we are trying to do in Milwaukee is to get vocational training on a learning-while-earning basis. Ours is a supplementary school, endeavoring to do in school the things that are usually neglected. We are trying to cover the different phases of trade, commerce, and industry, and with cooperation on the part of others we shall be able to cover the whole field adequately and comprehensively.

Progress of Vocational Education

In discussing the papers presented at the Milwaukee meeting, Frank Cushman, chief of the Industrial Education Service of the Federal Board for Vocational Education, Washington, D. C., referred to the progress being made in vocational training. According to Mr. Cushman, the need for vocational education, of which apprenticeship in the skilled trades is but one phase, has been generally recognized for a number of years. During the eight-year period prior to the passage of the National Vocational Education Act of 1917, vocational education in the industrial field had been a topic of major importance, and for a number of years bills had been introduced into Congress and hearings held before congressional committees for the purpose of devising ways and means of meeting the needs of the situation. A report of President Wilson's Commission on Vocational Education, made in 1914, set forth very clearly the reasons why apprenticeship and other forms of industrial education constituted a problem of national importance, and it was largely as a result of the work of this commission that Congress enacted the law commonly known as the Smith-Hughes Act.

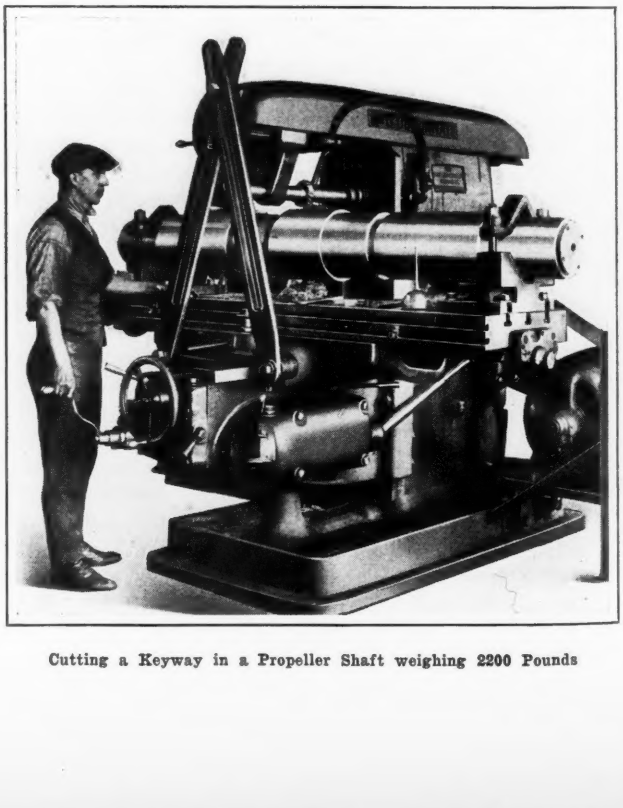
Under the provisions of this act, forty-eight state boards for vocational education cooperated with the Federal Board for Vocational Education for nearly eight years. In view of the facts in the case it can fairly be claimed that not only is there a national organization actively at work in promoting apprenticeship and other forms of industrial education, but that important, valuable, and far-reaching results are being secured under the National Vocational Education Act. In 1917 only three or four of the states had developed trade schools. In 1924 approximately 410,000 persons were enrolled in publicly supported trade and industrial classes. Of this number more than 300,000 are persons who have left the regular schools and entered employment in industry. Of the latter number at least 10,000 are apprentices in the skilled trades, the remainder being either young workers who were attending part-time schools or persons employed in industry who were attending evening trade-extension classes.

As an indication of the scope of this work a recent survey of trade schools in the United States showed that during the year 1923-1924 there were 1192 separate trade courses in operation in the United States, which met the standards set up by the federal and state boards. These courses were subdivided into 146 distinct courses of instruction dealing with more than 100 industrial occupations. The 146 distinct courses might be grouped into fourteen general classes of occupations for the purpose of illustrating the degree to which the public program of trade and industrial education is serving the needs of industrial workers. The number of employed workers enrolled in the public evening trade-extension classes was more than two and one-half times the number of boys and girls enrolled in the day and part-time classes covered by the survey. In the evening-school program, a recent review of the situation showed that there was no major group of industrial occupations, in which the workers had not been reached to a certain extent by the opportunities for education and training offered by the public schools.

* * *

MILLING A KEYWAY IN ONE-TON SHAFT

An unusual operation at the plant of an important electric company consists of milling a keyway in a propeller shaft that is 7 feet long, 11 inches in diameter at the largest section, and weighs over 2200 pounds. The keyway is cut 2 inches wide and 1 inch deep. This operation is performed on a Cincinnati No. 5 plain milling machine with the work mounted in a V-block at each end of the table, as shown in the illustration. It will be evident that in an operation on work of this weight a severe test is placed on the knee, saddle, and base, and extreme rigidity is required.



Cutting a Keyway in a Propeller Shaft weighing 2200 Pounds

Standardization of Machine Tools*

The Status of Standardization of Machine Tools in the United States, and the Agencies through which the Work is Being Performed

By S. EINSTEIN, Chief Engineer, Cincinnati Milling Machine Co., Cincinnati, Ohio

IN practically every technical journal nowadays, articles frequently appear describing one phase or another of standardization, and quite often they endeavor to show that standardization in a broader sense is the problem of today and is indispensable to the industrial life of the country. On the other hand, we occasionally hear voices raised against standardization as destroying individuality. Nevertheless, facts show that it is a check to individuality only if the latter is superficial and useless. Standardization encourages individuality where that feature counts most.

Secretary of Commerce Hoover, in discussing the problem of elimination of waste in industry has said: "It is certain that there are a great many articles of everyday use, in the standardization of which the manufacturer would indeed be glad to cooperate, which would mean a saving in national effort interpreted not in millions but in billions of dollars. This does not mean, however, that we stamp the individuality out of manufacture or invention or decoration; it means basic sizes for common and everyday things."

Webster defines a standard as "that which is established by authority, custom, or general consent as a model or example." Probably the most important standard of an international nature is our alphabet, which is used, with few exceptions, in all modern languages. The standardization of the meaning of words, of spelling, and of pronunciation is laid down in the dictionaries. The standardization of coinage, weights, and measures is essential in the life of every nation.

A Few Historical Data

Standardization of certain mechanical elements began a good many years ago in this country, the most typical example being probably the attempt to standardize screw threads. In 1864, a committee of the Franklin Institute recommended the adoption of a system devised by William Sellers, now known as the United States Standard. In 1895, the Hartford and Worcester machine tool builders issued standards for set-screws and cap-screws, also based upon the United States Standard screw thread. In 1906, the Association of Licensed Automobile Manufacturers adopted standards for automobile screws and nuts. In 1907, the American Society of Mechanical Engineers accepted the report of its committee on standard proportions for machine screws. In 1912, the Society of Automobile Engineers was organized and later adopted a fine-screw-thread standard, as well as many other dimensional standards for automobile materials and parts.

In July, 1918, the National Screw Thread Commission was appointed by Act of Congress, and after three years of painstaking work, it published its first Progress Report in January, 1921. This report was carefully studied by the sectional committee on the standardization and unification of screw threads organized under the procedure of the American Engineering Standards Committee. The sectional committee made a number of important recommendations, all of which were accepted. The report of the sectional committee was approved in the spring of 1924, after which it was published in pamphlet form in May, 1924. The final report of the National Screw Thread Commission was then issued in February, 1925.

*Abstract of an article in "Mechanical Engineering," the Journal of the American Society of Mechanical Engineers, for August, 1925.

This brief outline of the course of events necessary to unify the screw-thread systems of this country indicates plainly the length of time necessary to carry on such standardization activity, particularly when the product is as important a mechanical element as screw threads.

Stages in Standardization

Standardization may be considered as having passed through four stages; namely, (1) standardization within the factory; (2) standardization within certain industries; (3) national standardization; and (4) international standardization.

Every factory, large or small, has, of course, certain individual standards. The sizes of drawings and tracings, the information on these drawings, the method of dimensioning, and certain shapes and features of designs are generally standardized. It has a standard of materials, a standard of stock parts, such as special screws, bolts, pins, levers, etc. It occasionally standardizes a unit so that it will be interchangeable and can be used on various sizes and styles of machines, such as drive and feed-change mechanisms, friction clutches, toolposts, tool-holders, vises, chucks, aprons, tailstocks, etc. It generally standardizes the manufacture of various machines of the same or different design. It builds these machines in certain fixed quantities at one time; it has a standard system of issuing orders, and has standardized the manufacturing of these parts. It has standard equipment and standardized tools for the manufacture of these machines. In short, each and every department has certain functions to perform, and they all follow a certain standard in performing them.

This standardization within the factory can be, and in larger organizations is, of the greatest importance. The standards developed there are and must be the foundation of any new standard, inasmuch as they give the men entrusted with standardization a basis upon which to develop the new standard.

Standardization Affecting a Whole Industry

The next stage is the standardization in specific industries through trade associations and technical societies, and deals particularly with the standardization of certain functional or structural elements of the product of that industry. It has for its object standardization of sizes, styles, and dimensions to permit the same standardized parts to be included in various makes of machines. As a typical example of this stage may be mentioned the various standards adopted by the automobile industry: namely, the standardization of tires, starting units, spark plugs, carburetors, etc. The same standardization method is followed by the electrical industry. Electric lamps are generally interchangeable in their sockets. Standardization within the industry deals also with standardized specifications and standardization of certain fundamental dimensions; for example, in the milling machine industry the ranges of the various sizes of knee and column type milling machines are standardized. It deals also with the standardization of certain safety codes, etc.

Of still larger scope is standardization on a national scale. Practically all the civilized countries today have bodies that take care of national standardization on a larger or smaller scale—Australia, Austria, Belgium, Canada, Czecho-Slovakia, Finland, France, Germany, Great Britain, Holland, Hungary,

Italy, Japan, Norway, Poland, Russia, Sweden, Switzerland, and the United States—nineteen in all.

The American Engineering Standards Committee

In the United States, the function of national standardization is accomplished by the American Engineering Standards Committee, which serves as a national clearing house for engineering and industrial standardization, acts as the official channel of cooperation in international standardization, and provides an information service on engineering and industrial standardization matters. However, it may be said here that the ultimate responsibility for and control of the work rests with the member bodies of the organizations whose representatives constitute the American Engineering Standards Committee. It is the agency through which industrial standardization in this country is passing from the second to the third stage, namely, from standardization by associations, societies, and governmental agencies to standardization on a national scale. At the time of the organization of the American Engineering Standards Committee, there were hundreds of organizations publishing standards, most of which were formulated without systematic methods of cooperation or exchange of information between the organizations concerned.

The committee had its beginning in January, 1917, at a meeting of a special committee appointed jointly by the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials, for the formulation of some method of cooperation to prevent duplication in standardization work and the promulgation of conflicting standards.

What has been Accomplished by Standardization

In all 68 standards have been approved by the American Engineering Standards Committee, and 91 others are under way. Of the total 159 projects submitted, 32 have to do with civil engineering and the building trades; 26 with mechanical engineering; 17 with electrical engineering; 4 with automotive subjects; 9 with transportation; 1 with shipbuilding; 9 with ferrous metals; 14 with non-ferrous metals; 12 with chemical subjects; 2 with textiles; 16 with mining; 5 with the wood industry; 1 with the paper and pulp industry; and 11 with topics of a miscellaneous or general character.

Standardization on an international scale of certain dimensional standards and specifications was discussed at informal meetings of the secretaries of the national standardizing bodies. The first of these meetings was held in April, 1921, in London, and the second in July, 1923, in Zurich, Switzerland. Following the latter meeting, specific projects were discussed, and by special arrangement an international conference on ball bearings was held. This conference helped to bring to a satisfactory conclusion negotiations that had been carried on by mail for a number of years. It is now possible to state that there are 97 sizes and types of radial ball bearings that are recognized internationally.

A general conference on international standardization is now being discussed, and it is possible that unification of the dimensions of bolts, nuts, and wrench openings will constitute one of the projects to be discussed at that meeting. At present there is an exchange of ideas and of new standards between all national standardization committees, and the possibility of standardization of machine elements such as, for example, screw threads on an international basis, is also foreseen.

Standardization of Machine Tool Elements

At the present time, of the work accomplished by the subcommittees of certain sectional committees organized under the procedure of the American Engineering Standards Committee, the most important thus far completed is the standardization of screw threads. Another work undertaken under the auspices of the American Engineering Standards Committee is that of standardizing small tools and machine tool elements. This project is sponsored by the National Machine Tool Builders' Association and the American Society of Mechanical Engineers. It deals with the standardization of work-holding and tool-holding elements of machine tools, such as T-slots, spindle noses, and machine tapers, and small tools associated therewith.

Principles Recommended for Standardization of Machine Tools

The central committee met on April 26, 1922, and drew up the following rules to be used in its preliminary work: The desirability of standardization of various machine tool elements having been made evident, the work should be confined to the consideration of elements that affect both the user and the manufacturer. One group of these elements is naturally made up of those connected with tool-holding and work-holding, and some of the considerations affecting these are as follows:

1. As affecting a large variety of machine tools, the T-slot should be standardized, and perhaps T-slot bolts and nuts should be standardized at the same time.

2. As affecting many different kinds of machines on which it is desirable to interchange chucks or tools, spindle ends or spindle noses (as frequently designated) should be considered.

3. As affecting the use of wrenches, and to eliminate the monkey wrench, cooperation should be freely given to the committee that is standardizing bolt heads, nuts, and wrenches.

4. The standardization of tapers should also be considered, inasmuch as it affects a variety of machines.

5. Standard sizes or ratings of machines should be established. This would be in the nature of terminology or definition, so that a purchaser would know what was meant, for instance, by a 14-inch lathe.

6. Standard sizes, or intervals of size, should be determined for different groups of machines, and variances from the standard intervals should be discouraged, because multiplicity of sizes merely means additional expense to the industry with no corresponding gain to any one, either purchaser or manufacturer.

It was also recommended that the use of preferred-numbers series be promoted, these numbers to be used as nearly as possible in deciding on sizes of machines and ranges.

T-slot Standardization

The sub-committee appointed for the standardization of T-slots has finished a preliminary report and has sent out questionnaires to the various manufacturers. It is hoped that the various machine tool manufacturers using T-slots in their product will express their opinions as to the three specific proposals submitted.

The greatest variation in practice among the various machine tool builders is in the width of the throat. This is obviously the most important dimension, as it is the only one that greatly affects the interchangeability of attachments and fixtures. A considerable number of manufacturers provide T-slots of the same width as the nominal diameter of the bolt, the bolt itself being slightly under size. A still larger number provide T-slots wider (usually by 1/16 inch) than the nominal diameter of the bolt. The latter practice facilitates the use of T-nuts instead of the conventional T-bolts.

There is no need of reviewing the arguments concerning the relative merits of the two practices for width of throat. It is sufficient to point out that the mere fact that they are established will add to the difficulties of standardization. As a result of this difference in practice, the sub-committee has under consideration the following three proposals:

1. Throat width same as nominal diameter of bolt.

2. Throat width 1/32 inch or 1/16 inch greater than the nominal diameter of bolt.

3. Throat width optional, leaving the manufacturer a choice between the first two proposals, according to his preference or his past practice.

How Can T-slots Best be Standardized?

The question arises why the T-slot throat was made the same width as the bolt diameter. The author has been told by men working many years in the machine tool field that the original idea was to prevent the use of rough bolts in the T-slots of tables. In a 5/8-inch slot, only a finished 5/8-inch diameter bolt could be used or a rough bolt of 1/2 inch, which generally would be too small.

Today practically all the T-bolts used are either semi-finished or finished bolts, and, therefore, to give sufficient clearance for the bolt in the slot, and to avoid any sticking of the bolt, it is desirable to have the width of the T-slot larger than the bolt. It is hoped that the committee can see its way clear to adopt the standard where the width of the T-slot is larger than that of the bolt diameter, and that it will eliminate the present practice. This is not only desirable for the simplification of this T-slot problem, but also, as the author sees it, for the moral effect it will have, because if it is not possible to agree on some standard for such a simple element as a T-slot, it certainly will be much harder and more discouraging when the bigger problems of standardization still before us are encountered. It would also be desirable that, for certain machine tools, the distance between the various T-slots on the tables should be standardized, so that jigs, fixtures, and vises could be interchanged between various makes of machines.

As to other work-holding devices, it would be desirable that a standard should be laid down for the dimensions of chucks, faceplates, dogs, and drivers for work in lathes and grinders, etc., so that these devices could be used on the various makes of machines. This standardization should deal particularly with the dimensions of these devices at the point of their attachment to standard machine tools.

Taper Standardization

More complicated conditions are met with in the question of taper standardization. In October, 1922, a proposal was sent to the various machine tool makers by the National Machine Tool Builders' Association, dealing with standardization of tapers in the various machine tool spindles. The proposal recommended the adoption of both the Brown & Sharpe and Morse tapers as the standards, supplemented by three additional sizes of larger dimension taken from the Jarno taper and changed only in the length of the shank, which was shortened. The Brown & Sharpe taper is universally used for milling machines, and the Morse taper is used on drilling machines, and also to quite an extent on lathes. There are, however, some manufacturers who use the Jarno standard tapers or modified Morse or Jarno tapers of their own. The Brown & Sharpe taper consists of 16 different sizes, ranging from 1/4 inch to 2 1/2 inches in diameter, whereas there are only 8 sizes in the Morse system within the same range. There is a preference on the part of lathe and drilling machine designers for the Jarno or Morse tapers of 0.6 or 5/8 inch taper per foot on account of the end pressure frequently encountered by the tools on these machines, while the taper of the Brown & Sharpe system would cause the tools to stick harder and make their removal more difficult.

In the past, the driving of the arbor or cutter of a milling machine was done to a certain extent by the taper shank, and therefore a better "bite" of the shank was desirable. Today all milling machines for heavier cuts use a positive drive of the arbor, and this bite or grip is therefore not so essential.

It is very likely that the final outcome of the standardization work on tapers will be the use of the two standards, the Brown & Sharpe and the Morse, and this certainly will simplify the general conditions as to arbors, shank tools, shank drills, and centers materially.

Standardization of Spindle Noses

A more complicated problem is that of the standardization of spindle noses. Until recent years all machine tools with a rotating spindle had the spindle nose threaded at the front for attaching either tools or work-holding devices. With the use of heavier cuts on milling machines and with the running of the spindles in both directions, it was found that the old-style threaded spindle noses were not very satisfactory, and new constructions were developed and adopted by the manufacturers in this country and abroad. No two of these spindle noses are alike; some are similar in design but different in dimensions, so that for practically every make of milling machine, different face mills have to be used. There is no possibility of interchanging the arbors. The result is that large numbers of duplicate tools are required in any shop where different makes of milling machines are employed. Practically the same conditions exist in the case of other machine tools, such as lathes, for example, where the spindles of various makes differ in diameter and in the number of threads. The functions of the spindle end on a lathe and on a milling machine are somewhat similar, and an attempt should be made to devise a standard for spindle noses that will be applicable to all machine tools where the functions are the same or similar. No serious objections were raised by the users of milling machines when manufacturers changed their spindle noses, and the author feels that if a real standard could be developed for these various tools, the users of machine tools would be only too glad to accept it, as it would reduce considerably the number of cutters, arbors, chucks, faceplates, etc., they are obliged to carry in their tool-rooms.

From the author's personal experience in the standardization of spindle ends at the works with which he is connected, he can say that one standard of spindle nose will cover a considerable range of sizes of machines. The Cincinnati Milling Machine Co. uses on all its single-pulley and automatic machines, spindle noses of exactly the same dimensions. It uses this one standard spindle nose on a No. 5 miller with 20 horsepower capacity and also on a No. 1 machine with a 3-horsepower motor. In all these machines, the company uses a No. 14 B. & S. taper hole, so that the arbors, shell end mills, face mills, and similar tools are completely interchangeable on all sizes of its machines.

Other Standardization Work

Another sub-committee, now in formation, will deal with the standardization of lathe and planer tool-holders and toolpost openings to permit the interchange of tools in lathes, shapers, and planers. It is not the intention here to recommend any particular design, but only to point out that the essential aim is to provide interchangeability for the various tools and machine elements.

Wheel collets for grinding machines are another desirable element to be standardized. A modern machine shop does not want to take a wheel off a collet before it is to be finally discarded, due to the necessity of rebalancing the wheel when it is mounted again on the collet. Therefore, for every grinding machine a number of collets should be in use. With the standardization of these wheel collets for grinding machines, it would be possible to reduce the number of chucks. The author does not know of any committee that is working on this problem.

Standardization of Gearing

The standardization of spur, helical, herringbone, bevel, and worm gearing, covering general gear proportions, tooth form, mounting of gears, the selection of material, and the inspection of gears, is being formulated by a committee sponsored by the American Gear Manufacturers' Association and the American Society of Mechanical Engineers. No doubt much benefit will be derived by machine tool builders from this standardization of the gears used in their machines.

Sponsored by the National Machine Tool Builders' Association and by the National Bureau of Casualty and Surety Underwriters, a safety code for machine tools is in preparation. This code will deal with the operation of such machine tools as lathes, shapers, gear-cutters, milling machines, etc., and will no doubt serve as a guide for the machine tool designer in safeguarding the operators of such machines.

Small Machine Parts

A number of committees are at work on the standardization of other machine elements, such as pins and washers, bolts, set-screws, nuts, fillister-head screws, wrenches, etc. Standardization of limits and tolerances for the various kinds of cylindrical machine fits, including allowances and tolerances for interchangeable manufacturing, has progressed satisfactorily. The work of classifying and fixing standard tolerances for plain limit gages and methods for gaging these classes of fits will be completed by a committee in a very short time. The sponsor for this work is the American Society of Mechanical Engineers.

With the increase in power requirements due to the heavier cuts of machine tools, it has been found desirable in certain places to do away with ordinary keys for the mounting of members, and the system of shafts with integral keys already adopted by the automobile industry will, it is hoped, more and more come into favor in the machine tool industry. It is desirable that a standard for these shafts be developed, for their employment would result in saving a considerable amount of money, inasmuch as standard broaches could be used in their manufacture.

The designation of sizes of machine tools by figures, such as No. 2 milling machines, 14-inch lathes or 6-foot radial drills, does not give a true picture of the machines in question. It would be advisable to revise our method of designating machine tool sizes in such a way as to give a better conception of capacity, and especially should the power requirement form a part of the designation.

Motor Drive for Machine Tools

More and more is the individual motor drive being used in machine tools, but different speeds, different sizes of frames, different shaft diameters and different voltages make the incorporation of motors into the machines very expensive and difficult. The standardization of motor frames, motor speeds, and armature-shaft diameters is very desirable indeed, and a committee of representatives of the electrical industry in cooperation with the machine tool industry should consider this problem. Just as serious as the electric motor problem, is the application of the control apparatus, some of which are of still larger dimensions than the motor itself. In a large number of cases, under present conditions, it is impossible to incorporate this control apparatus in the machine, and unsightly appearance generally results.

In this respect a good deal of work has been done in Germany, where the author has seen planers driven by reversing motors, with the control apparatus inside the housings. In other machine tools, the Germans frequently use barrel-shaped or flanged motors, which give the machine tools a neat appearance. The author has been informed that they have also standardized certain dimensions such as, for example, shaft diameters.

Standardization of Drafting-room Practice

At present hardly any two factories use the same method of dimensioning drawings, the same indications as to materials, finish, tolerances, and other information such as drilling, boring, scraping, etc., and it is therefore necessary for every new employe to learn each new method. The author does not see any reason why a standard could not be adopted that would take care of the various kinds of information a drawing is expected to give; and if such a standard were uniformly adopted, it would make it less costly for the employer and easier for a new employe to work his way into a new position, inasmuch as he would be fully acquainted with the standardized system. Incidentally, the sizes of drawings could be standardized so that drawing and tracing paper of the same size and standardized cabinets for storing them could be used.

Conclusion

The author has attempted to give a general idea of the status of the standardization of machine tools in this country at the present time and of the agencies through which this work is performed. It is desirable that this work be kept up, and that through cooperation between engineers, manufacturers, and users of machine tools, results be obtained that will be of benefit to the industry at large as well as to the country. Of course, the individual machine tool manufacturer has to say whether or not he wants certain elements of his products standardized. Now this standardization work is, to a large measure, within his control. But if he does not exercise this control, standards may be forced upon him by the users that do not meet the problems of modern machine tools and that may be very expensive to comply with.

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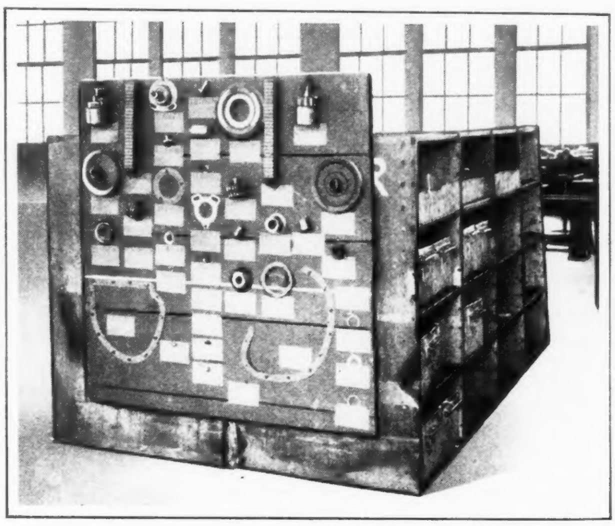
CONVENIENT SYSTEM OF INDICATING CONTENTS OF STORAGE BINS

The accompanying illustration shows an interesting method used at the plant of the Packard Motor Car Co. to aid the men employed in the assembly departments in finding parts in the storage bins. At one end of the storage bin is a board, as shown, on which all the parts contained in the storage bins are mounted in the same relative position that they occupy in the different compartments in the bin. For example, the part shown in the upper right-hand corner of the board is stored in the upper right-hand compartment of



A Board on which the Contents of Storage Bins are indicated

the bin. In this way the approximate location of every part is quickly indicated, and no time is lost hunting through a number of compartments before the right one is found. This simple method has been found a very effective time-saver in the Packard plant.

* * *

MOTOR BOAT ENGINEERING MEETING

Engineers of the Society of Automotive Engineers who are interested in motor boat engines and accessories will hold a one-day technical session for the discussion of pertinent engineering subjects in New York City the last week in August during the Manhasset Bay motor boat regatta on the north shore of Long Island. The date has not been definitely selected nor the plans completed, but the meeting is expected to be held in the Belmont Hotel, New York City. Further information may be obtained from the Society of Automotive Engineers, 29 W. 39th St., New York City.

FORTY YEARS IN THE MACHINE TOOL BUSINESS

August H. Tuechter, president of the Cincinnati Bickford Tool Co., Cincinnati, Ohio, has just completed forty years of association with the company of which he is now directing head. In celebration of his fortieth anniversary, a luncheon was given in his honor at the Business Men's Club in Cincinnati, July 13, by friends of Mr. Tuechter, both inside and outside the machine tool industry.

Mr. Tuechter was born in Cincinnati in 1869, and became office manager of the Bickford Drill Co. in 1887. In 1893, when this company was reorganized under the name of the Bickford Drill & Tool Co., Mr. Tuechter became general manager and partner in the business. In 1899 he entered into partnership with S. C. Schauer, who for eight years previous had been superintendent of the Hamilton Machine Tool Co., Hamilton, Ohio. They formed the Cincinnati Machine Tool Co., specializing in the building of upright drilling machines, while the Bickford Drill & Tool Co. continued to concentrate on the manufacture of radial drills. In 1909 the two companies were consolidated under the name of the Cincinnati Bickford Tool Co., of which Mr. Tuechter then became president, a position which he has held ever since. Mr. Tuechter is recognized as one of the prominent leaders in the machine tool industry, to whose advance he has devoted his entire life. He was president of the National Machine Tool Builders' Association from 1920 to 1922.

A. H. Tuechter

* * *

FIFTIETH ANNIVERSARY OF THE LINK-BELT CO.

Fifty years have passed since the incorporation of the Ewart Mfg. Co., the forerunner of the present Link-Belt Co., in 1875. In commemoration of the fiftieth anniversary, the Link-Belt Co. has published an attractive book entitled "Link-Belt 1875-1925."

In this book it is mentioned that the patent of William Dana Ewart, a young implement dealer, from Belle Plain, Iowa, for the detachable link chain, was dated September 1, 1874. Mr. Ewart first started to build a self-binding harvester, but he realized the great need in such a machine for a detachable chain drive that could be repaired in the field; and he worked out the idea of a chain drive, the links of which could be easily replaced by the farmer, who up to that moment had been wasting much time in going back to the barn or blacksmith shop for necessary repairs to the "strap link" chain drives that were used on some of the first crude binders; or trying to adjust the flat belts, which stretched and tightened under varying conditions of heat or moisture in the field.

Late in 1874 when Mr. Ewart came to Chicago with a view to arousing some interest in his "detachable link chain," he succeeded in interesting John C. Coonley, a lawyer who was then president of the Chicago Malleable Iron Co. As a result a company was duly incorporated in 1875, under the name of Ewart Mfg. Co., for manufacturing detachable link chain. In 1876, the Ewart chains were exhibited at the Philadelphia Centennial Exposition, and an agency of the company was established in Philadelphia.

New uses for the new chain rapidly developed, and in 1880 the Link-Belt Machinery Co. was incorporated "to design, build, and supply accessory parts, and install elevating and conveying machinery employing Ewart chains." In the early years the business consisted almost exclusively of the manufacture and sale of detachable chain for power transmitting purposes, but the idea of using chain for the continuous handling of materials of all kinds had already been given attention by Mr. Ewart, and the formation of the Link-Belt Machinery Co. was the first step to bring this idea to a practical conclusion. In 1882, the company opened a New York office, and in 1888, the Pennsylvania representatives and the New York office were consolidated under the name of the Link-Belt Engineering Co. In that year a plant was also built at Nicetown, Philadelphia, where the newly opened offices of the Link-Belt Engineering Co. were located.

Mr. Ewart's plan of a general manufacturing organization, the Ewart Mfg. Co., selling through two engineering organizations—the Link-Belt Machinery Co. and the Link-Belt Engineering Co.—which latter found increasing use for chains in engineering applications, undoubtedly resulted in the rapid growth of the business in its early development; but the growth of large consolidations about twenty-five years ago, and inroads by competitors, suggested that the three separate units of the Link-Belt group should be brought under an effective and centralized control. Hence, in 1906 the three companies were consolidated by the purchase of the Ewart Mfg. Co. and the Link-Belt Engineering Co. by the Link-Belt Machinery Co., the consolidation being known as the Link-Belt Co.

Since the consolidation in 1906, Charles Piez, who had been with the Link-Belt Engineering Co. since 1889, has been the executive and financial head of the Link-Belt Co. Two specially equipped plants—one for making malleable iron castings, and one for manufacturing heavy steel and malleable iron chains—have been added since the merger, thereby completing the company's lines of sprocket chains for elevators, conveyors, and power transmissions. The Link-Belt Machinery Co. and Link-Belt Engineering Co. also early developed systems for storing and reclaiming coal in large quantities; and in their separate and consolidated organizations have been extensive builders of coal tipples, coal washeries, sand and gravel washeries, locomotive cranes, crawler type cranes, dipper shovels, etc., as well as portable loaders, coal crushers and feeders, boiler house equipment, and screens of various types, including vibrating screens, sewage screens, and traveling water screens.

It is of interest to note that it has been one of the policies of the company for the last fifteen years to encourage the transfer of the company's stock from the hands of inactive stockholders to those of men engaged in the organization. Today fully 35 per cent of the stock is held by employes of the Link-Belt Co.

From its main offices in Chicago, the company now operates manufacturing plants in Chicago, Indianapolis, Philadelphia, and San Francisco, also having shops in Seattle, Muskegon, and Toronto, and sales and engineering offices in twenty-seven of the largest American cities.

* * *

According to price indexes comparing costs of a great number of articles, it is found that commodities in general are priced 67 per cent higher than before the war. The automobile industry is one of the few that sells its products for less than the pre-war price. In 1924, the price of automobiles, for equivalent types of cars, was 29 per cent less than before the war. Despite this fact, the automobile industry, in 1924, earned on an average 12.2 per cent on the capital invested, thereby ranking first among the more important industries of the country. In the same year the railroads earned only 4.4 per cent, the iron and steel industry 7 per cent, and banks 8.5 per cent.

USE OF ELECTRIC HOT-PLATE FOR TEMPERING

A unique application of an electric hot-plate for drawing the temper of the working ends of open-header dies and solid cold-forging tools is made at the plant of the Buffalo Bolt Co., North Tonawanda, N. Y., manufacturer of bolts, nuts, wire and bar material. At this plant, many tools and dies are made that must be especially heat-treated in order to obtain production output on automatic and semi-automatic machines. In the case of header dies and solid cold-forging tools, it is essential that the body of the tool be of unusual hardness, it being necessary, at the same time, that the working ends themselves have less of the characteristic of hardness and more that of toughness.

The dies and tools are first heated to a temperature of 1450 to 1500 degrees F. in an electric furnace, and then quenched in a saline solution. After cooling, they are again heated, this time in an electrically heated oil tempering bath to a temperature of approximately 450 degrees F. They are then allowed to cool to normal air temperature. Ordinarily, this cycle would constitute the complete heat-treating process.

The tools and dies in question, however, are subject to great strains and shocks. In the case of carriage-bolt open-header dies, particularly, the square neck opening, with its sharp corners, constitutes a weak working part, and unless sufficient toughness is imparted to the metal at this point, the life of the die will be short.

Accordingly, in order to provide the proper element of toughness at the point where it is needed, without destroying the great hardness in the body of the dies and tools themselves, the Buffalo Bolt Co. has installed an electric hot-plate for tempering the ends. The dimensions of the plate are approximately 9 by 18 inches, and the electric heating element, suitably insulated, is cast in the plate itself, providing a strong construction for withstanding the severe service imposed. The plate rests on a small, electrically welded frame about 2 feet in height.

After cooling from the oil tempering treatment, the working ends of the dies and tools are polished with emery cloth. They are then placed on the heated plate and left there until the ends assume a bluish color, indicating that the drawback operation has been completed, after which they are removed and allowed to cool in the open air. The hardness of the working ends is thus reduced to give greater toughness and less brittleness, the original hardness of the tool and die body being retained. The operation is quickly performed, and has been found to increase materially the life of the dies and tools in question.

The plate has been found to be simple and inexpensive, clean and safe, giving off no smoke, soot, or fumes. The plate, oil tempering bath, and electric furnace used in the operations described are all General Electric products.

* * *

Work has recently started at the shipyard of William Cramp & Sons, at Philadelphia, on a new liner *Malolo*, which will run between San Francisco and Honolulu, and which will be the largest and fastest passenger ship ever built in the United States. The cost of this vessel, when completed, will be $6,560,000. In the design, the naval architects, Gibbs Brothers, Inc., have made provision for converting the vessel into an auxiliary cruiser or troop transport in case of a national emergency. The ship will have a speed of 22 knots, a length of 582 feet, a width of 83 feet, and a displacement of 22,000 tons. The *Malolo* is a twin screw vessel driven by geared turbines developing 25,000 horsepower at 120 revolutions per minute.

HEAT-TREATMENT FOR TAPS AND MILLING CUTTERS

The following data cover the practice recommended by the American Society for Steel Treating (4600 Prospect Ave., Cleveland, Ohio) for taps and milling cutters made from plain carbon tool steel, 18 per cent tungsten high-speed tool steel, and 1.50 to 2.00 per cent tungsten tool steel, and must not be applied to taps and milling cutters having a chemical composition other than that given in Table 1.

COMPOSITION AND ANNEALING TEMPERATURES

Table 1. Approximate Chemical Composition in Per Cent

Elements in Steel	Plain Carbon Tool Steel		18 Per Cent Tungsten High-speed Steel		1.50 to 2.00 Per Cent Tungsten Tool Steel	
	Min.	Max.	Min.	Max.	Min.	Max.
Carbon	1.00	1.30	0.65	0.75	1.00	1.30
Tungsten	....	.....	17.50	18.50	1.50	2.00
Chromium	....	.....	3.25	4.25	0.50	(Optional)
Vanadium	....	.....	0.75	1.25	0.25	(Optional)
Manganese	....	0.35	.....	0.35	....	0.35
Phosphorus	....	0.030	.....	0.030	....	0.030
Sulphur	....	0.030	.....	0.030	....	0.030
Silicon	....	0.30	.....	0.35	....	0.35

Table 2. Annealing after Forging and Before Machining

Kind of Steel	Method	Temperature, Degrees F.	Time of Heating to Uniform Temperature	Time of Holding at Temperature	Where Cooled
Plain Carbon	Pack Anneal or on Charcoal Bottom	1450	1 Hour per Inch of Diameter or Thickness*	1/2 Hour	Furnace†
18 Per Cent Tungsten High-Speed	Non-oxidizing atmosphere	1600 to 1650	1 Hour per Inch of Diameter or Thickness	1/2 Hour	Furnace
1.50 to 2.00 Per Cent Tungsten	Pack Anneal or on Charcoal Bottom	1475	1 Hour per Inch of Diameter or Thickness	1/2 Hour	Furnace

*When pack-annealing, consider the container and contents as one unit.
†If lead bath or salt bath is used for heating, cool in lime, mica, or infusorial earth.

Table 3. Annealing for Relieving Machining Strains

Kind of Steel	Temperature, Degrees F.	Time of Heating to Uniform Temperature	Time of Holding at Temperature	Where Cooled
Plain Carbon	1400	1 Hour per Inch of Diam. or Thickness	1/4 Hour	Furnace
18 Per Cent Tungsten High-speed	1500	1 Hour per Inch of Diam. or Thickness	1/4 Hour	Furnace
1.50 to 2.00 Per Cent Tungsten	1450	1 Hour per Inch of Diam. or Thickness	1/4 Hour	Furnace

Machinery

The annealing of steel forgings previous to machining consists of heating and cooling.

Heating—The steel is placed in the furnace on a charcoal covered bottom (except high-speed steel), and heated slowly and uniformly to the temperature given in Table 2, which is held for a sufficient time to obtain the complete penetration of heat and refinement of grain. It is recommended that the steel, especially the high-speed steel, be heated in a closed pipe or box containing some carbonaceous material.

Cooling—The steel is then cooled either in the furnace, in infusorial earth, mica, lime, or any medium that will

permit uniform slow cooling and prevent excessive oxidation.

Annealing to Relieve Machining Strains

Heating and cooling comprise the annealing operations employed to relieve the machining strains. The taps or milling cutters are placed in a box containing some carbonaceous material (except in the case of high-speed steel). The box is placed in the furnace, heated to the temperature given in Table 3, and then allowed to cool in the furnace.

Heat-treating Taps and Milling Cutters

After machining, the taps and milling cutters are heated for quenching, quenched, and then tempered.

Heating for Quenching—The taps or milling cutters are heated uniformly to the temperature given in Table 4, and the temperature is held at this point until complete penetration of the heat is obtained.

Quenching—The heated work is quenched in water, brine, or oil as indicated in Table 4, but must not be allowed to cool below the temperature of boiling water—212 degrees F.

Tempering—After the work is quenched, it is reheated immediately in oil, salt, or a furnace for the time and temperature specified in Table 5.

HARDENING AND TEMPERING

Table 4. Heating and Quenching Taps and Milling Cutters

	Preheating			Heating for Quenching		Quenching	
Kind of Steel	Medium	Temperature, Degrees F.	Means of Heating	Temperature, Degrees F.	Time	Medium	Temp. Deg. F.
Plain Carbon	....	....	*	1425 to 1450	1 Hour per Inch of Diameter or Thickness	Water or Brine	Water 70
18 Per Cent Tungsten High-speed	Open Furnace	1500 to 1550	Open Furnace	2250 to 2300†	‡	Oil	70
1.50 to 2.00 Per Cent Tungsten	....	....	....	1450 to 1475	1 Hour per Inch of Diam. or Thickness	Water or Brine	Water 70

*If a lead bath is used for heating, a higher temperature and shorter time should be used. When heating the steel in an open furnace, either an indirect fired furnace (muffle) should be used or a smoky flame should be maintained.

† A temperature as high as 2350 degrees F. may be used provided the furnace design is correct and the atmosphere is suitable.

‡ Hold shortest time possible to thoroughly heat through.

Table 5. Tempering Taps and Milling Cutters

Kind of Steel	Tempering Medium	Tempering Temperature, Degrees F.	Time
Plain Carbon	Oil	325 to 500*	1/2 to 1 Hour
18 Per Cent Tungsten High-speed	Furnace	1100 to 1200	30 Minutes
1.50 to 2.00 Per Cent Tungsten	Oil	325 to 500*	1/2 to 1 Hour

*Depending on degree of hardness or toughness desired.

Machinery

* * *

The program of the American Foundrymen's Association Meeting and Exhibition to be held in Syracuse October 5 to 9, inclusive, will include fourteen technical sessions. There will be a joint meeting with the Metals Division of the American Institute of Mining Engineers. Other sessions will be devoted specifically to the gray iron foundry, the steel foundry, aluminum and aluminum alloys, apprentice training, sand control in the foundry, and malleable cast iron. Further information may be obtained from the American Foundrymen's Association, Marquette Building, 140 S. Dearborn St., Chicago, Ill.

TRADE ASSOCIATION STATISTICS

Development and proper use of business statistics by trade associations, along the lines laid down by the recent decisions of the United States Supreme Court, is strongly urged by the Department of Manufacture of the Chamber of Commerce of the United States in a bulletin just made public. The bulletin starts out by stating that "for years trade associations have been faced with doubts about statistical activities in which they could lawfully engage. The members of many associations had come to fear that statistics of any kind were, in the opinion of prosecuting officials, inherently wrongful, when they related to economic activity, although in every other walk of life statistics were held in high esteem.

"In this situation the Supreme Court itself has granted relief. On June 1 it handed down its opinion in two cases brought by the Department of Justice against trade associations, holding that the statistical activities of these associations were lawful. Thus, these opinions serve to indicate for all trade associations that there is no violation of the federal anti-trust laws if they gather and distribute the essential business facts which the Supreme Court described.

"With the clearer understanding of this liberty under the law (which remains unchanged), there is no bar to the development and proper use of business statistics. This clearing of atmosphere should mark the passing of guessing as to the facts concerning our commodity production and distribution provided there is a willingness, at source, to supply the information. It is in the hands of each member of an industry to make possible complete and accurate figures for his line by his own contribution.

"Trade associations will undoubtedly appreciate the opportunity of rendering to their constituency valuable service by providing means for the gathering and reporting of statistics dealing with such important trade information as producing capacity, orders, shipments, stocks, and markets as shown by prices on closed transactions.

"In the renewing of statistical activities, it is timely to suggest simplification of methods and forms in order that the information which is found be obtained and presented as quickly and accurately as possible at the minimum of expense. Such uniformity will enable the transmission of information gathered in the form of charts or graphs, when desired, as this is much less cumbersome than presenting great masses of figures. If uniformity of method is observed, it would greatly simplify the matter of not only charting a given line but also including such other lines as may be of collateral interest or important in comparing the trends of the industry. One of the essentials of statistics is that they shall be current as well as dependable."

A very large number of trade associations are at present engaged actively in gathering and distributing such information, and the service that will thereby be rendered to industry is of great value.

The Machine-building Industries

ONE of the most favorable conditions in the business situation is the absence of any general recession in activity such as took place last year at this time. The level of business activity is distinctly higher than a year ago. This view is reflected not only by the statements of the Federal Reserve Bank, but also by numerous business associations. When the Atlantic States Shippers Advisory Board met recently, the reports of the various commodity committees indicated that a 5 per cent increase in railroad shipments may be expected during the next six months, the increase being heaviest in leather and rubber goods (25 per cent), followed by petroleum products (20 per cent), and heavy machinery, iron ore, slate, and paint (15 per cent). In the shipments of electrical machinery, an increase of between 5 and 10 per cent is expected. General manufacturing production, according to the Department of Commerce, averages from 15 to 20 per cent higher than for the corresponding months in 1924; and furthermore, the month of June showed increases over May in many of the basic industries. Decreases were recorded only in the iron and steel industry and the automobile industry; in the latter, the decrease was only 2 per cent.

The Federal Reserve Bank of Cleveland points to the objectionable features of the present policy of hand-to-mouth buying, as compared with the policy of buying for reasonable future requirements that has prevailed in the past. There are several causes for the present policy, among which may be mentioned the greatly improved transportation service, insuring prompt deliveries; the fact that the manufacturing capacity in most lines is ahead of demand; and the lesson of five years ago when manufacturers and merchants were left with large accumulations of stocks on their hands.

The objections are: (1) The hand-to-mouth buying policy prevents manufacturers from planning ahead, and their production schedules must be based on guesses and estimates, resulting sometimes in over-production and sometimes in under-production. (2) Manufacturing costs are increased due to uneconomical operation and the necessity of carrying larger stocks of finished goods at the factories; this means a reduced turnover, and results either in smaller profits or higher costs to the consumer. (3) Small lots are more expensive to produce per unit than larger lots, and small shipments are more expensive than carload shipments. (4) Manufacturers are likely to be rushed at certain times to fill orders that are needed in a hurry, while at other times, the plants may be partially idle. Altogether, it seems that the hand-to-mouth buying has greater disadvantages than advantages, and for industry as a whole, it results in a planless method of conducting business.

The Machine Tool Industry

The demand for machine tools continues to show an improvement. Some substantial railroad orders have been placed during the past month, and some orders of reasonable size have also been placed by industrial schools. Ernest F. DuBrul, general manager of the National Machine Tool Builders' Association, points out that for the last four and one-half years the curve for machine tool orders has conformed quite consistently to the curve for the production of pig iron, but for some months past, while pig iron production has been falling off, machine tool orders have increased. No definite explanation has been offered why this should be so, but it is likely that, on the one hand, the iron and steel manufacturers over-produced and are decreasing their output until the excess stocks accumulated have been sold, while on the other, the cheap money now available has resulted in increasing the machine tool demand. Desirable replacements can be made with money borrowed at low interest, and it certainly is the best kind of business policy to borrow cheap money to take advantage of the greater earning power of new equipment. "Another factor probably also enters into this demand situation for machine tools," says Mr. DuBrul. "There is more intelligent and general attention being given by the machine tool industry to selling production and not pounds."

The Iron and Steel Industry

Steel ingot production decreased about 7 per cent in June, as compared with May, but it is worthy of note that, nevertheless, the production in June was 55 per cent greater than for the same month last year; and the ingot production for the first six months of this year was 13 1/2 per cent greater than for the same period a year ago. These figures indicate a sustained state of business activity, despite the temporary recession from the somewhat feverish buying that took place during the first months of the year. Prices are showing slight increases, and it is likely that the uncertainty in the price situation has passed. Operations in the steel industry range from 60 to 65 per cent of capacity, with a gradual tendency toward increased production.

Production of pig iron was 6 per cent less in June than in May. Nevertheless, at the present time, production of pig iron is fully 50 per cent greater than a year ago. It should also be noted that the slowing down of operations in pig iron output appears to have reached a halt. Only five pig iron furnaces were blown out in June, as compared with twenty-four in May. The price of pig iron is quite certain to turn upward, and men who carefully study the market advise the buying of pig iron at this time, although they admit that it is doubtful whether the demand for pig iron will be sufficiently strong to produce a heavy rise in price.

It is of interest to note that during the first six months of the year, the output of pig iron and steel showed the largest total for any similar period since the war, with the exception of 1923; during the war it was exceeded only once —in 1918. Production during the first six months of 1925 was 22,250,000 tons; in 1923, for the same period, 23,327,000 tons; and in 1918, 22,531,000 tons.

The Automobile Industry

The record of the automobile industry for the first six months of 1925 was as remarkable as it was unexpected. June production was well maintained, the total output being 396,000 cars and trucks, against 404,300 in May—a decrease of only 2 per cent, which is unusually small at this season of the year. The total production for the first half of the year is slightly in excess of the record-breaking period of 1923. During July, the seasonal reduction in output set in more rapidly, most factories operating at from 10 to 15 per cent below the June schedules, while further decreases are expected during August. It should be noted, however, that the conditions are much better than "normal" for this time of the year, and several prominent automobile concerns have not yet caught up with their sales. All the well-known automobile builders have had unusually good business up to this time, including bigger exports than ever before.

Wherever material reductions in manufacturing costs have been made possible by improved equipment, the automobile industry has been a consistent buyer of new machinery. Few people outside of the automobile factories realize how closely costs are scrutinized in these plants, and how thoroughly the possibilities of reducing costs by improved equipment are examined.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

NEW BRITAIN CHUCKING MACHINE

There are many instances where the actual cutting time of parts handled in chucking machines has been reduced to the minimum by the use of proper tools, feeds, and speeds, and where the only possible method of further reducing the floor-to-floor time would be to lower the time consumed in reloading the work. This manner of increasing production was given prime consideration in developing the No. 12-A chucking machine recently brought out by the New Britain Machine Co., New Britain, Conn., and as a result, the machine is equipped with air cylinders that control the operation of work-holding chucks. In tending this machine, the sole duty of the operator consists of loading the chucks and turning a valve handle when the loading has been accomplished, to admit air into the corresponding chuck cylinder. As the operations on a part are completed, the chuck valve handle is automatically swung into the open position and the work slides from the chuck. By means of this arrangement three out of five of the customary movements of the operator are dispensed with.

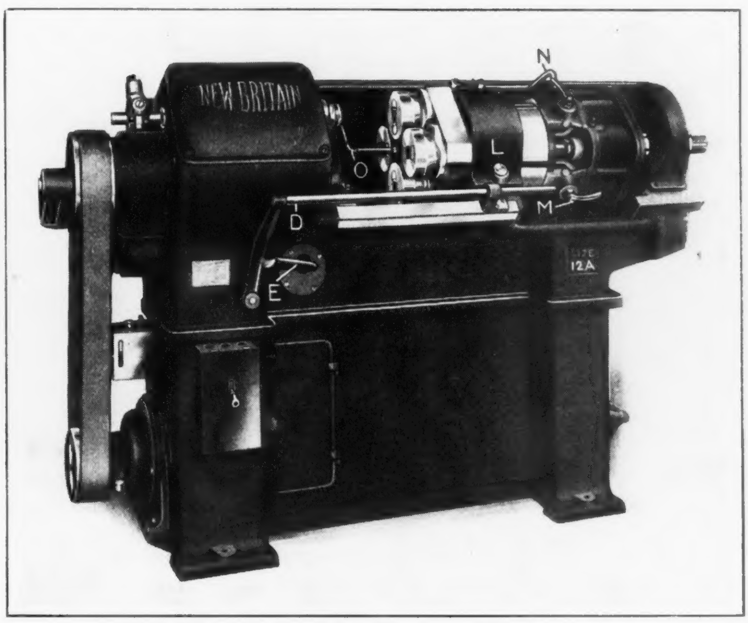


Fig. 1. New Britain Chucking Machine of the Tool-rotating Type, equipped with Pneumatically Operated Work-holding Chucks

The machine can be set to give as high a production as 40 pieces per minute, which corresponds to 2400 pieces per hour. High spindle speeds are available for finishing brass pieces, but the spindles can also be operated at slower speeds for machining iron and steel castings, etc. There are three tool-spindles, and these are rotated and fed to and from the work. Four work-chucks, of which one is always idle, are held stationary in a turret that is indexed one position between each reciprocation of the tool-spindles. Work up to 2 inches in diameter can be handled with standard tools, and threads up to 1 inch can be cut. The spacing of the work-spindles around the turret permits of swinging pieces up to about 5 inches in diameter.

Driving and Feeding the Tool-spindles

Power for actuating all movements of the machine is derived from a constant-speed motor, running at 1800 revolutions per minute, which is placed in the headstock end of the base, as illustrated in Figs. 1 and 2. The power is delivered by belt to a single pulley, mounted on the main driving shaft, which is located in the center of the headstock. Through slip change-gears and intermediate gears in the headstock, the tool-spindles can be run at different speeds of from 360 to 2060 revolutions per minute. The speed of these spindles may be independent of each other, which is also true of the feeds. The first and second spindles are customarily used for boring or turning, and the third spindle is ordinarily used for threading, but may also be used for reaming or turning. The slip change-gears are accessible through covers on the headstock.

At the rear of the machine, as shown in Figs. 2 and 3, there is a drum *A* on which cams are mounted for controlling the feed of the tool-spindles. Holes are jig-drilled around this drum, so that various combinations of cams may be employed. The cams for the first and second spindles are of the solid type, while that for the third spindle is adjustable to suit any lead of thread that the machine is capable of cutting. The feed of the cams is imparted to the spindles by means of yoked levers, such as illustrated at *B*, Fig. 2, which carry rollers bearing against the cams. These yokes are equipped with ball thrust bearings.

Different rates of spindle feeds can be obtained with any given set-up of cams by changing the speed of rotation of the drum. This is accomplished through feed-box *C*, which is driven by sprockets and a silent chain from the main driving shaft, the feed-box being arranged to rock around the center of one gear train so as to take up any slack in the silent chain. Slip change-gears in the feed-box provide for driving the cam-drum and its shaft at thirteen rates of speed, in geometrical progression, ranging from 177 to 2370 revolutions per hour. These rates correspond to the number of reciprocations of the work-spindle per hour and to the number of parts finished. Each spindle is fed rapidly to the work, then fed at a slow rate for the operation, and finally, given a quick return to the starting point. A ratchet device permits the spindle to be advanced at the same rate as the fastest feed. All three tool-spindles have a stroke of 2 1/2 inches.

The drive from the feed-box to the cam-drum is through worm-gearing, the gear being bolted to the drum. The latter, in turn, is keyed to its shaft, which runs the full length of the bed and carries other cams that control all mechanisms at the right-hand end of the machine. Engagement and disengagement of the drive to the cam-drum is accomplished by operating rod *D*, Fig. 1, which is attached to a shaft extending through the bed, that controls the position of a friction clutch in the feed-box. When the clutch is disengaged, arm *E* of the lever operated by rod *D* is swung away from an opening that it covers when the machine is in operation. A crank can then be inserted into this opening to revolve a shaft for "turning over" the machine by hand. This is a convenient feature in setting the machine up for a new class of work. Arm *E* of the operating lever simply acts

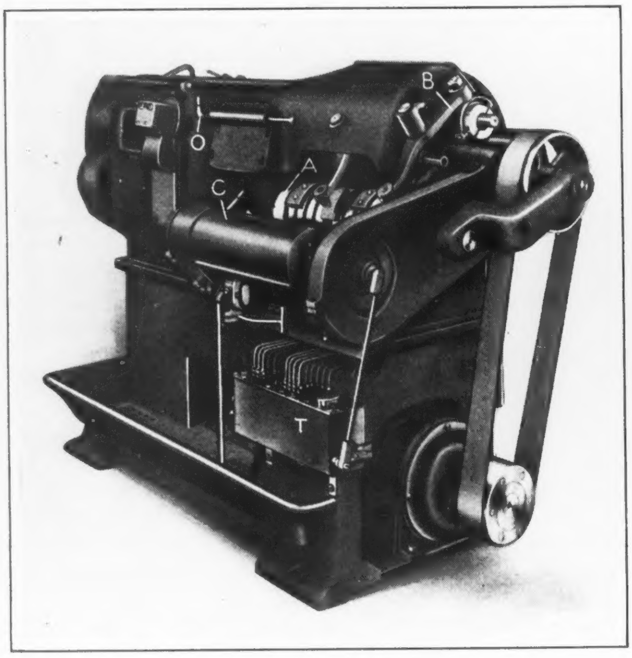


Fig. 2. Driving Arrangement employed on the New Britain Chucking Machine

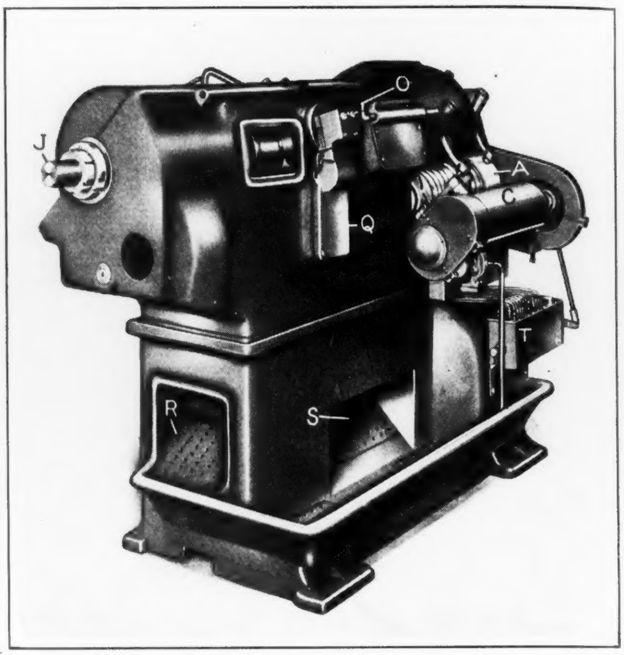


Fig. 3. Rear View, illustrating the Separate Chutes for the Work and Chips

as a safeguard to prevent the application of the hand-crank when the clutch is set for operating the machine by power.

The Work-turret Unit

The work-turret unit is illustrated in Fig. 4, from which it will be seen that the unit consists essentially of a turret *F* in which four chucks are mounted, a cylinder housing *G*, and a Geneva wheel *H*. The indexing of the turret is accomplished by means of an arm which intermittently engages the four slots in the Geneva wheel. This arm is driven from the camshaft through elliptical gears, designed to spread the indexing time of the turret over a large portion of each revolution of the camshaft. The 90-degree movement of the Geneva gear is accomplished during a 122-degree movement of the camshaft, which makes the indexing a gradual acceleration and then a gradual retardation to the idle position, the movements being accomplished without shocks.

The work-turret may be adjusted to and from the tool-spindles any amount up to 4 inches, by revolving a nut on screw *J*, which is provided with a micrometer dial, as illustrated in Fig. 3; this dial is graduated to 0.001 inch, in order to enable accurate settings of the turret. It is necessary that the turret be indexed accurately before each reciprocation of the tool-spindles and that it be gripped firmly during the operation. Hence, the turret is locked after each indexing by means of a rectangular-section bolt which successively enters slots *K*, Fig. 4, spaced equidistantly around the turret. This bolt is controlled by a cam on the camshaft, being entered into the slots by a spring action, and positively released. The gripping is accomplished through clamp *L*, Fig. 1, a bolt on the clamp being operated automatically by another cam on the camshaft. This bolt is tightened by a spring, and positively loosened. The locking and binding bolt mechanisms are accessible through cover *Q*, Fig. 3. Slots *K* in the turret are never exposed to dirt.

The Pneumatic Chucking Mechanism

Chucks of various types may be provided to suit the work; however, collet chucks of the draw-back type with either two or three jaws are regularly furnished. The jaws are equipped with pads that are circular on the outside and shaped on the inside to suit the work. Two-jaw air chucks of the screw type can also be furnished when the jaws must be opened wide to receive irregular shaped work. Draw-back thread arbors and special chucking fixtures may be supplied to suit other conditions. All chucks can be hand-operated whenever air is not available or when hand operation is desirable.

With the regular air-operated collet or screw chucks, handle *M*, Fig. 1, of any valve is operated by hand after the work has been seated in the respective chuck. Air is then admitted into the back of the cylinder, forcing the piston forward so as to close the chuck jaws. When that particular chuck is indexed again into the idle position at the end of the operation, its valve handle strikes hook *N* so that the handle is swung over to admit air into the front of the cylinder and force the piston back. The work then drops from the chuck jaws, and the air is discharged through the chuck to keep it free from chips and dirt.

Air is supplied to the cylinders through piping *O*, Figs. 1, 2, and 3, which shortens and lengthens as the turret is adjusted along the bed. Less air is required for operating the collet chucks than for the screw chucks; hence filler blocks are used to shorten the cylinders when the machine is equipped with collet chucks. The cylinders are made accessible by removing the cover plate at the right-hand end of the casting.

Other Details of Construction

One of the important features of the machine is the construction of the frame. The bed and base have been recessed at the front so that the operator can load the work and manipulate the valve handles while he is seated on a chair. The bed has been strengthened by running a wall to the complete height, from the headstock to the opposite end, the different finished surfaces provided for the turret clamp, etc., being machined at an angle to permit this construction. With this design, the turret is well supported, because it is surrounded with metal for a distance of more than the usual 180 degrees. As shown in Fig. 3, there are two inclined chutes *R* and *S* in the bed, through the first of

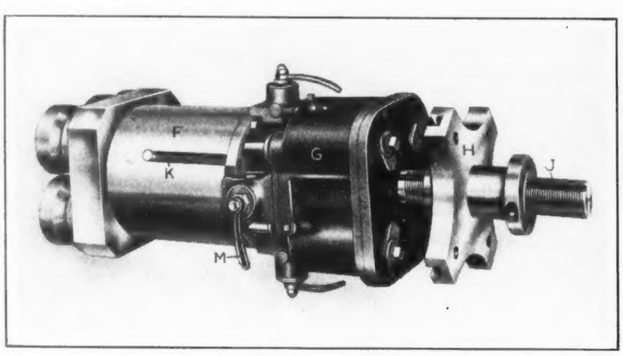


Fig. 4. Construction of the Work-turret Unit

which the work slides as it drops from the chuck, while the chips slide down chute *S*. The floors of these chutes consist of gratings through which all coolant drains to a reservoir in the bed, from which it is again delivered to the tools by a geared pump.

A multiple force-feed lubricator, located at the rear of the machine as shown at *T*, Figs. 2 and 3, and driven from the feed works, delivers lubricant to all bearings. It is located below the bearings so as to eliminate siphon action. The level of the oil in the tank can be observed through a sight-glass from the front of the machine. Spare change-gears are kept in a compartment in the base, accessible through the door on the front. This door also gives access to the inner bearings of the motor.

The No. 12-A machine here described weighs about 3700 pounds. A larger No. 23-A machine that will weigh about 5500 pounds is also being developed. This machine will have only slight differences in construction from the one described, but it will be equipped with four tool-spindles and five work-spindles. The center-to-center distance of the work-spindles will permit swinging work up to 7 inches in diameter.

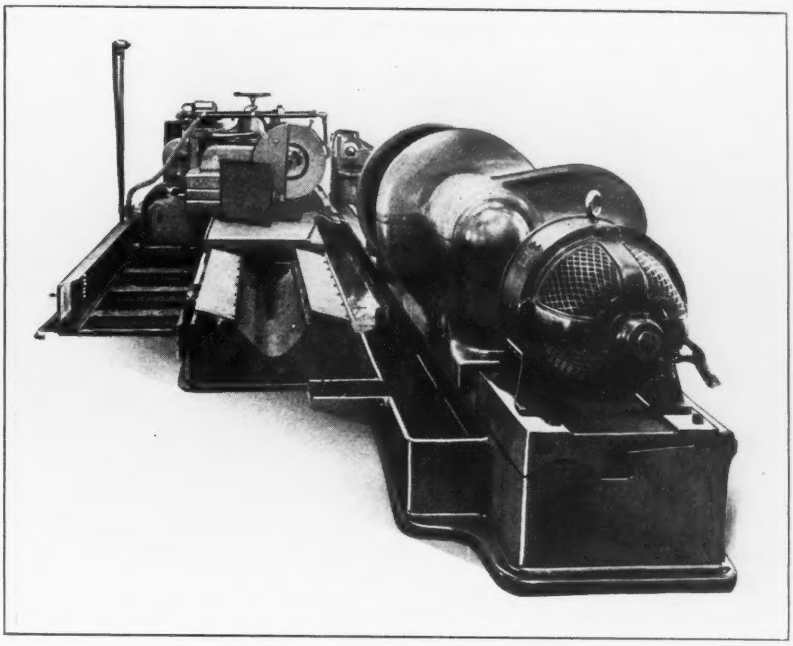


Fig. 2. View of the Roll Grinding Machine from the Work-head End

LANDIS ROLL GRINDING MACHINE

One of the largest grinding machines ever built has just been finished by the Landis Tool Co., Waynesboro, Pa., for grinding chilled iron and steel rolls weighing up to 56,000 pounds, and steam-engine piston-rods up to 16 inches in diameter by 22 feet long. The machine will swing work up to 52 inches in diameter over the bed, and will accommodate work up to 24 feet long, between centers. In general design, the machine is similar to the roll grinder built by this company for the last five years, but some new features have been incorporated. The various units are much larger, and the total weight is considerably more, being 110,000 pounds exclusive of the electrical equipment. The main bed alone weighs approximately 60,000 pounds.

The main bed is made in four sections with a division lengthwise along the water channel and crosswise at about the center. The headstock and footstock are carried on bearing surfaces directly on top of the front bed section. These surfaces are inverted-vee and flat guides of which the vee-guide controls the alignment. The headstock is located in a fixed position, while the footstock can be moved the entire length of the bed through a mechanism consisting of a rack fastened in the center of the vee-guide, a pinion for the rack, and a worm and worm-wheel. Power is applied to the worm-shaft by means of a large crank-handle. The gear ratio of this mechanism is such that although the footstock weighs 6000 pounds, it can be moved with little effort.

The headstock is connected through a flexible coupling to a 25-horsepower adjustable-speed motor which supplies power for driving the work only. The headstock is equipped throughout with cast-steel herringbone gears of the Sykes type, running in a bath of oil. A back-gear arrangement, controlled by a lever on the front of the headstock, furnishes two speeds for the main spindle, and additional speeds are secured through the adjustable-speed motor. Speeds ranging from 4 1/2 to 72 revolutions per minute are obtainable with this arrangement. The spindle bearings, which are 23 and 16 inches long, respectively, are lubricated through a force-feed system, driven by a plunger pump attached to the first drive shaft in the headstock. This pump also forces oil to all bearings of the auxiliary shafts, and draws the oil from a reservoir in the bottom of the headstock.

The grinding wheel head weighs 9000 pounds, and is carried on two vee-guides, set well apart to insure alignment, ease of movement, and rigidity of support. Power for driving this head is delivered by a 30-horsepower adjustable-speed motor. The spindle bearings are also lubricated automatically by a force-feed system. Movement of the wheel-head toward and away from the work is accomplished by turning a large-diameter handwheel equipped with a graduated dial reading to 0.001

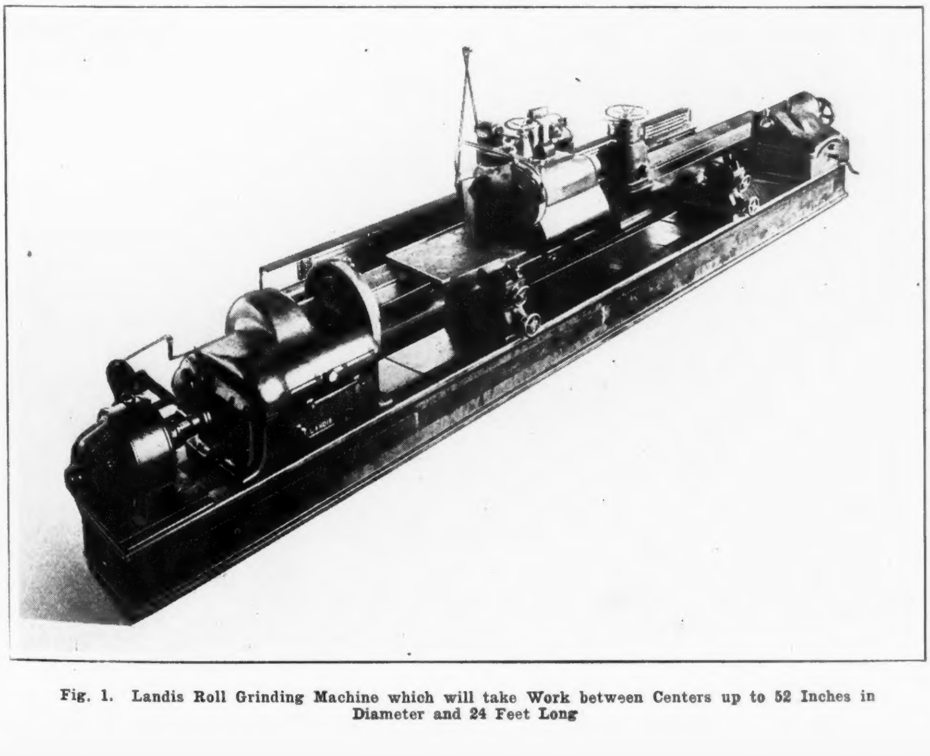


Fig. 1. Landis Roll Grinding Machine which will take Work between Centers up to 52 Inches in Diameter and 24 Feet Long

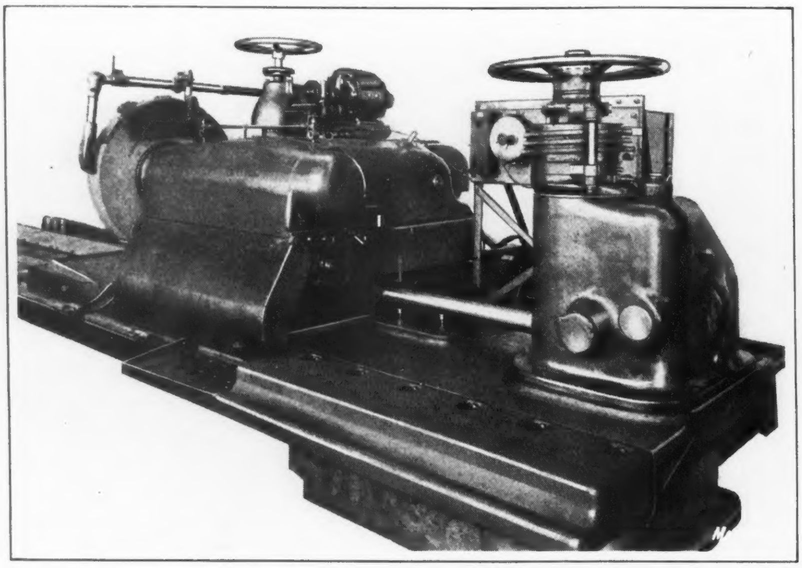


Fig. 3. Grinding-wheel and Carriage of the Roll Grinding Machine

inch. A two-horsepower reversible motor, mounted on the wheel-head and operated by a drum controller within easy reach of the operator, furnishes a rapid power movement of 2 feet per minute in either direction. The carriage on which the grinding wheel head and reversing mechanism are mounted also slides on two vee-guides. The bearing surfaces of the bed and the carriage are chilled to withstand wear. They are protected throughout their length, and lubricated from reservoirs by rollers located at intervals along the bed.

One of the important features of the machine is a built-in mechanism that provides for grinding rolls either concave or convex. The grinding wheel head is trunnioned at the rear, and the front is carried on hardened steel rollers resting on hardened cams, which give a constant rise to the grinding wheel head and are rotated to produce various amounts of crown or concavity. The vertical movement of the wheel-head, combined with the traversing movement of the wheel carriage, makes possible the production of curves that are correct, regardless of the amount of crown or concavity. Change-gears give various speeds for the cams, and these can be readily selected for a job from a graphic chart furnished with the machine.

Roll-carrying heads of the two-bearing type are provided, the bearing blocks of which are adjustable to accommodate rolls having journals of various diameters. It is possible to put a roll on the centers, adjust the bearing blocks to the necks, and withdraw the centers. Then, although the necks may be of different diameters, the body of the roll will be ground to the same diameter at each end. This fixture insures parallelism of straight rolls, and in the case of concave or convex rolls, it insures that the high or low point of the curve will be in the center of the roll. A straight ground bar, mounted on the front of the machine parallel to the travel of the grinding wheel, carries an indicator which permits the operator to check the roll frequently for parallelism or camber.

A water tank is constructed as part of the machine foundation, with various compartments holding 900 gallons of water. The channel in the bed also acts as a water tank, and has a capacity of 300 gallons, so that the total capacity is 1200 gallons. The water pump is driven by a five-horsepower motor. The motors for the grinding wheel and headstock are controlled by push-buttons from the platform of the operator.

PRATT & WHITNEY THREAD MILLER

A 10-inch thread miller of new design has been brought out by the Pratt & Whitney Co., Hartford, Conn., to replace the 12-inch model formerly made. The new machine is more convenient, more powerful, and faster than the previous machine, although the working principle is practically the same. It is built in two lengths, with maximum center distances of 24 and 60 inches, respectively, but longer machines can be built to order.

Power for driving the machine is derived from a 7 1/2-horsepower motor running at 1750 revolutions per minute, which is mounted on a hinged platform within the cabinet leg beneath the headstock. The hinged platform provides for tightening the belt from the motor, which drives a friction-clutch pulley on a drive shaft at the rear of the machine. If a belt drive from a countershaft or from a lineshaft is desired, it is a simple matter to use the same pulley without changing the machine further.

In general, the thread miller consists of a work-head which rotates and indexes the work, a lead-screw equipped with gearing for obtaining the necessary range of thread leads, and a cutter-head which is adjustable to suit the various angles and depths of threads to be cut. Single rotating cutters shaped to the thread form are used, as may be seen from Fig. 2. Power is delivered to the work-head and the lead-screw from the constant-speed drive shaft through clutches and gearing, the work-head and the lead-screw being each equipped with a gear-box. This drive permits cutting thread leads of from 1/12 inch to 48 inches, and provides seventeen work speeds ranging from 0.04 to 0.635 revolution per minute.

Indexing of the work for cutting multiple threads is accomplished by means of a notched ring, which is easily accessible in front of the spindle bearing. This indexing ring is solid, whereas in the previous model it had to be made in two pieces because it was inconveniently located between the spindle bearings. As a third gear-box is provided for obtaining the cutter speeds, the three factors of work speeds, thread leads, and cutter speeds can be reg-

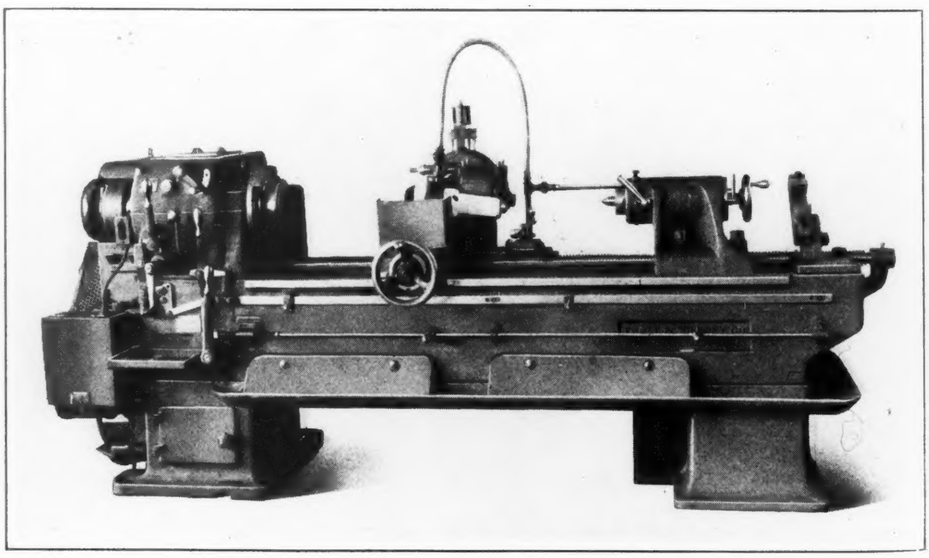


Fig. 1. Pratt & Whitney Thread Miller of Improved Design

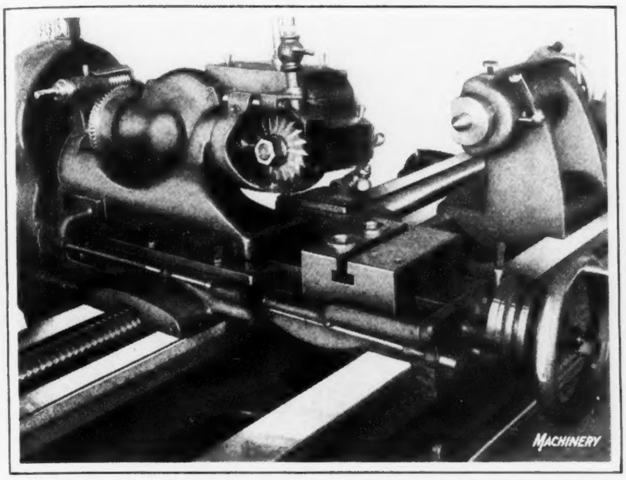


Fig. 2. Cutter-head and Cross-slide of the Thread Miller

ulated separately. In the previous model, the drive to the machine was through a three-step cone pulley, with the result that when the belt was changed on the cone pulley, the speed of the entire machine was changed.

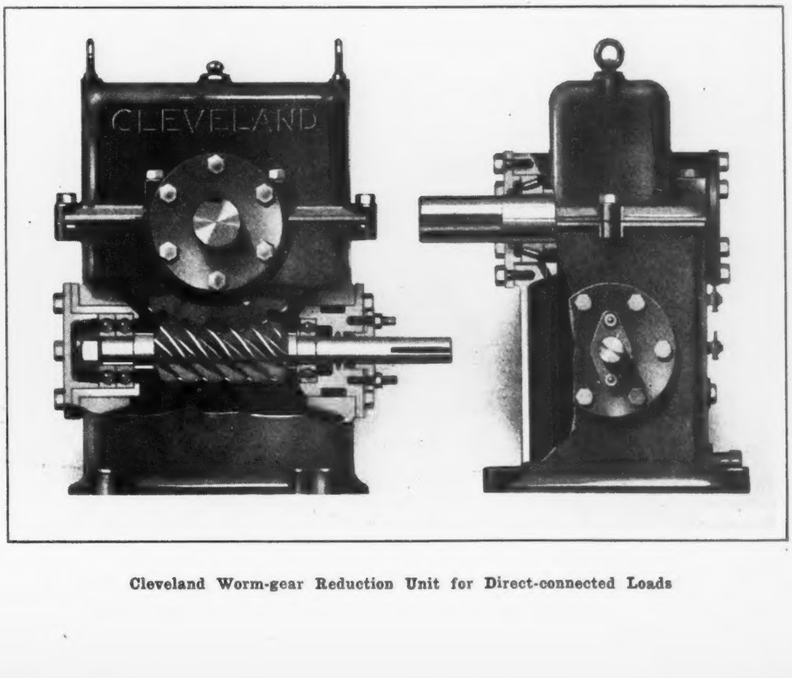
A marked improvement in the cutter-head is that the gears are heat-treated and run in oil, so that more power is available at the cutter. The cutter drive, including the gearbox of this unit, is lubricated from a central system. Five cutter speeds ranging from 29.3 to 96.2 revolutions per minute are obtainable. The cross-slide is provided with a positive stop for its screw, which enables the operator to return the cutter to an exact depth for milling a succeeding piece of work, after the cutter-slide has been backed out at the end of a cut. In the previous machine it was necessary to count the number of turns of the handwheel as the cutter was backed away, which made possible errors on the part of the operator. There is a sufficient travel of the cross-slide to accommodate work 10 inches in diameter, cut to a depth of 1 9/16 inches. The tailstock has been made heavier, and is equipped with a double clamping arrangement. In addition to thread-cutting operations, this machine may be used for milling keyways, annular grooves, spline shafts, etc.

CLEVELAND WORM-GEAR REDUCTION UNITS

A new line of type AT worm-gear speed reduction units intended for use with direct-connected loads is now being introduced on the market by the Cleveland Worm & Gear Co., Payne Ave. and E. 40th St., Cleveland, Ohio. These drives embody features of the type AH units brought out by the same company about two years ago to accommodate overhung loads. The new units are built in a large number of ratios from 4 to 1 up to 100 to 1, and in load capacities of from 1/4 to several hundred horsepower. As illustrated, the worm is mounted below the worm-gear, but it may also be mounted above the gear, in which case the unit is known as the type RT.

A feature of these reduction units is the use of tapered roller bearings in the gear-shaft mounting. Ball bearings are furnished for the worm. The bearing at the inner end is of the combined radial and thrust type, which is capable of taking thrust in both directions, and therefore the worm can be rotated in either direction to suit the requirements. The ball bearing at the outer end of the worm-shaft is of the radial type, arranged to float in the casing and to accommodate the lineal expansion of the worm. All bearings and the gearing are lubricated by the splash of oil from a large reservoir in the bottom of the housing. One filling of the reservoir provides effective lubrication for several months.

The shaft extensions of the units are provided with keyways for the attachment of flexible couplings. Petcocks for determining the oil level, lifting rings for the upper section, and tapped and plugged holes for the attachment of water cooling coils, are provided. The distances between the worm and gear centers and between the shafts and the bottoms of the housing, conform to standards established by the company, so all types of Cleveland units are interchangeable.



Cleveland Worm-gear Reduction Unit for Direct-connected Loads

ATKINS POWER HACKSAW BLADES

Power hacksaw blades made to a new steel formula and given a special heat-treatment are being introduced on the market by E. C. Atkins & Co., Indianapolis, Ind., under the trade name of "Silver Steel." The teeth of these blades are evenly set on each side, milled with round gullets, and accurately spaced; however, the important feature of the manufacturing process is the heat-treatment. Each blade gives the same amount of service, with small variations and with little difference in the time required for the operation from the first cut to the last. While the blades cost about five times as much as other hacksaw blades of the same specifications, they are guaranteed to cut six times as long or six times as much material and to cut from 50 to 100 per cent more rapidly. The following examples are given by the company to substantiate the claims made for the blades:

At one plant, a "Silver Steel" blade lasted twelve days during which period the blade was in operation constantly and cut high-speed and high-carbon steels 30 per cent of the time. At another plant a blade 12 inches long, 1 inch wide, 0.065 inch thick, and having 10 teeth per inch, was used for cutting 2-inch round S. A. E. 3120 steel. The time consumed in making the various cuts was taken at random in order to determine how the blade stood up in actual operation. It was found that the time consumed in cutting the 53rd, 77th, 101st, 127th, 150th, 184th, 204th, 215th, and 230th pieces was 1 minute 50 seconds; the 250th, 288th, and 300th pieces, 2 minutes no seconds; and the 311th, 339th, 356th, and 400th pieces, 2 minutes 5 seconds. Thus the variation in time between the 53rd and 400th pieces was only 15 seconds.

Eighty pieces of S. A. E. 3120 steel, 4 5/8 inches in diameter, were cut in a machine equipped with an 18-inch blade having six teeth per inch, which was operated at 80 strokes per minute. The first piece required 15 minutes for cutting off, and tests taken with every ten pieces up to the 80th piece showed that the cutting time never exceeded 17 minutes. These hacksaw blades are made in lengths of 12, 14, 17, and 18 inches; 1 inch wide; 0.065 inch thick; and with 6 or 10 teeth per inch.

AMERICAN SENSITIVE RADIAL DRILLING MACHINE

Spindle speeds up to 2000 revolutions per minute are obtainable on the "Maxi-Speed" sensitive radial drilling machine now being placed on the market in 3-, 3 1/2-, and 4-foot sizes by the American Tool Works Co., Cincinnati, Ohio. The builder states that the maximum speed is the highest ever provided on a machine of this type. Holes up to and including 1 inch in diameter can be drilled, and counter-boring operations can also be performed. The machine is intended for use in operations on such parts as switch-boards; electrical, cash-register and sewing-machine parts; and automobile chassis, transmission cases, engine frames, and accessories.

Three types of drive are furnished for the machine—a belt drive, an adjustable-speed motor drive, and a constant-speed motor drive. With a belt drive, the machine is equipped with a four-step cone pulley, as shown in Fig. 1. The driving belt is supplemented by a belt that delivers the power from the cone-pulley shaft to the vertical belt that drives the arm shaft. Eight spindle speeds ranging from 400 to

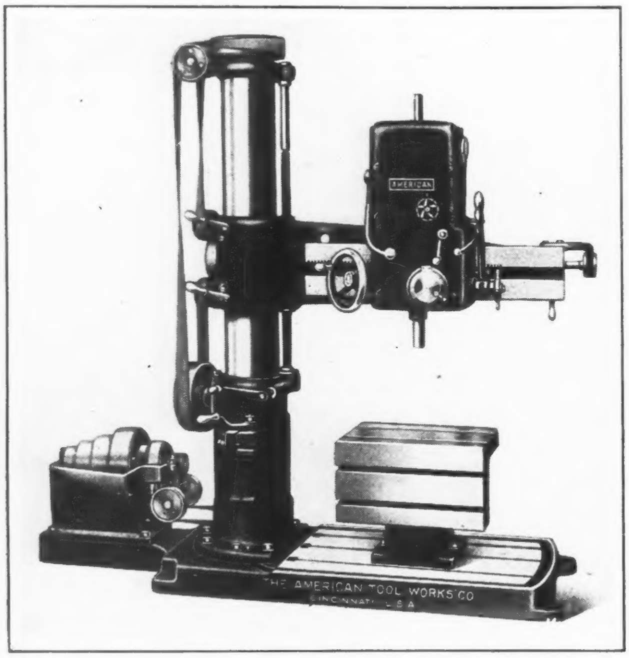


Fig. 1. American Sensitive Radial Drilling Machine which may be run at Spindle Speeds up to 2000 Revolutions per Minute

2000 revolutions per minute are available with this type of drive.

On the motor-driven machines, the motor is mounted on the radial arm, and the only belt used is one that drives the head. Fig. 2 illustrates the adjustable-speed motor drive, which is designed exclusively for direct-current motors. The motor is of three horsepower capacity, and has a wide range of speeds, from 500 to 2000 revolutions per minute, the number of speeds depending upon the controller. The motor is connected to the horizontal driving shaft by means of a flexible coupling which safeguards both the electrical and mechanical equipment from shocks incident to starting and reversing the machine.

The constant-speed motor drive consists of a three-horse-power squirrel-cage alternating-current motor, mounted on the radial arm as shown in Fig. 3, and connected to a six-speed gear-box which is interposed between the motor and the horizontal driving shaft. The gear-box is of the tumbler type, and provides speeds of from 500 to 2000 revolutions per minute. A friction is automatically disengaged when the tumbler lever is raised to disengage the gears, and re-engaged when the gears are thrown into mesh. This arrangement permits the gears to slow down during the changing of speeds so that the engagement of gears is accomplished practically instantaneously and without undue shock.

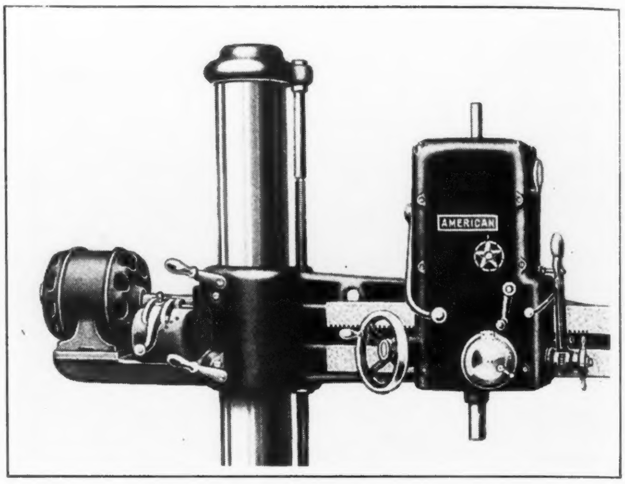


Fig. 2. Adjustable-speed Direct-current Motor Drive

The friction also provides a yielding member in the drive, which protects the electrical and mechanical transmission against sudden shocks.

All operating levers are placed on the head, for the convenience of the operator. The feed-lever is located directly in front of the operator on the right-hand side of the head, where it will not interfere with the work. The feed-lever is of the ratchet type, and when placed in the vertical position it is automatically disengaged from the rack-pinion shaft. Then the spindle can be adjusted quickly up or down by means of a handwheel on the end of the rack-pinion shaft, this feature being handy for moving the drill rapidly to and from the work. The tapping attachment lever through which the spindle is started, stopped, and reversed, is located on the left-hand side of the head. Power is transmitted to the spindle through hardened and lapped multiple-disk clutches, which are operated by imparting only a slight movement to the control lever. To obtain a quick response of the spindle to the movements of the control lever, a brake is incorporated inside the head which automatically acts on the spindle driving pulley when the lever is thrown into the neutral position. This brake stops the spindle quickly and relieves the clutches of the necessity of overcoming the momentum of moving parts.

In addition to the sensitive or lever feed, the machine is equipped with a power-feed mechanism. Three rates of power feed are provided, namely, 0.003, 0.006, and 0.010 inch per spindle revolution. The feeds are obtained through a small gear unit fully enclosed in the head, which receives power from the spindle. A direct-reading dial on the front of the head indicates the feed rates, and by bringing to a fixed pointer, any feed rate marked on the dial, the feed is automatically engaged. This sensitive drilling machine is equipped with the standard base, column, and adjustable

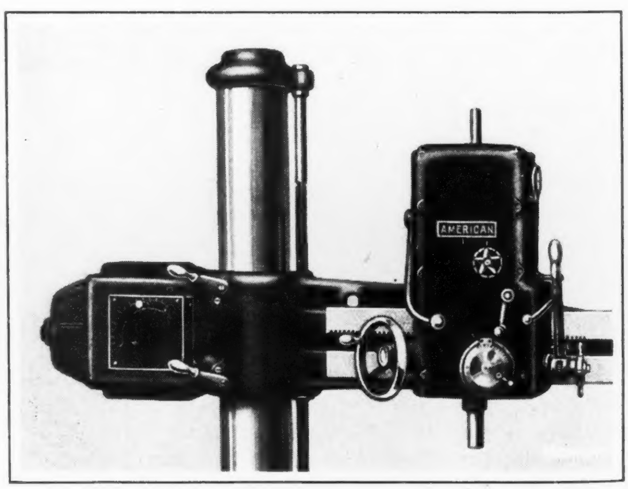


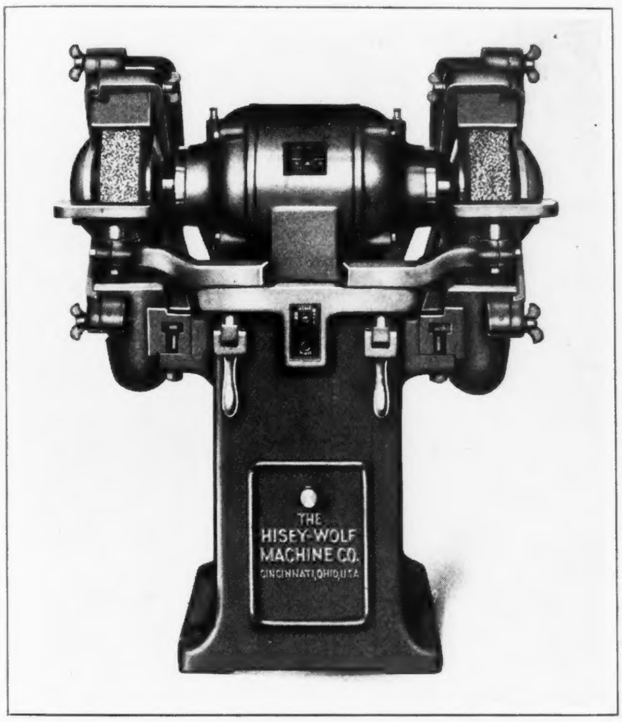
Fig. 3. Constant-speed Alternating-current Motor Drive

arm construction used in the triple-purpose geared radial drilling machine built by this company.

Different styles of tables may be supplied to suit the work. There is a separate round pedestal table which may be revolved on a vertical axis; a box table that can be swung around the column out of the way when it is desired to place work on the base; a box table that can be swiveled about a horizontal axis by means of worm-gearing; a plain box table; and a universal table. The 3-foot machine weighs about 3200 pounds; the 3 1/2-foot machine, 3400 pounds; and the 4-foot machine, 3600 pounds.

HISEY FLOOR GRINDER

A five-horsepower grinder designed to be equipped with two wheels, 18 inches in diameter by 3 inches face width, is a recent development of the Hisey-Wolf Machine Co., Cincinnati, Ohio. Under continuous use, the motor is guaranteed not to exceed a temperature of 40 degrees C. It is said to withstand a momentary overload up to 10 horsepower, a 50 per cent overload for one hour, and a 25 per cent overload for longer periods, without any appreciable change in temperature. One of the features is an automatic starter which throws the current on and off and insures motor protection at all times. The operating button is located on the front of the machine, and the switch proper is enclosed in the base.



Hisey Grinder equipped with Automatic and Self-resetting Starter

The wheel guards are of a one-piece construction, and are provided with exhaust pipe connections and hinged doors which permit quick access to the wheels. As the wheels wear, the guards can be adjusted back so as to keep the periphery of the grinding wheel in close proximity to the opening of the guards, giving maximum working space for the operator. A spark and chip breaker fitted to the top of each guard is readily adjustable by means of a winged nut. The spindle is 2 1/2 inches in diameter and the wheels are mounted directly on it. The grinding rests are adjustable, and can be removed. The weight of this machine is about 1100 pounds.

VICTOR COLLAPSIBLE REAMER AND TAP

The machining and tapping of seats in gate valve bodies are usually slow and expensive operations because of the thread diameter of the seats being larger than the pipe ends of the valve body. Such a construction prevents the use of a tap for cutting the thread for the seat ring. To permit these operations to be accomplished in an accurate and economical manner, the Landis Machine Co., Victor Plant, Waynesboro, Pa., has recently developed two collapsible tools, which can be easily inserted through the pipe ends of the valve body and then expanded to suit.

Fig. 1. Victor Collapsible Counterbore and Reamer designed for machining Gate Valves

One of the tools is fitted with plain cutters for reaming and counterboring the seat, and the other with chasers for tapping the seat. From the illustrations, it will be seen that the cutters and chasers are of double form, so as to permit machining and tapping both seats at the same set-up. An adjustment of approximately 1/16 inch, either over or under size, is provided for machining as tight or loose a fit as may be required and to compensate for cutter wear.

In performing an operation, the tool with the reaming and counterboring cutters is inserted first, and by throwing over the operating handle, the cutters are expanded into the proper radial position. The seat on the far side of the valve is first reamed, and counterbored if necessary, and then by drawing back the turret without reversing the machine, the forward seat is similarly machined with the opposite ends of the cutters. When this operation has been completed, the tool is collapsed by means of the operating handle, and withdrawn. The second tool fitted with the chasers is next similarly inserted, and the seat on the far side of the valve tapped first. As the tap is collapsed by means of the handle at the completion of the thread, it is unnecessary to back the tap off the thread. The machine is reversed for tapping the forward seat, and the opposite ends of the chasers are used. Angle-seat valves can be handled by swiveling the valve body in a holding fixture. Standard taps have been developed for all sizes of valve bodies from 2 to 8 inches.

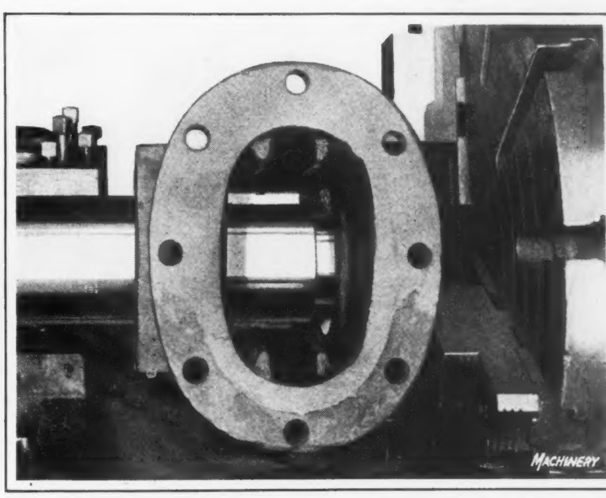


Fig. 2. Close-up View of the Threading Operation which shows the Double Form of the Cutters

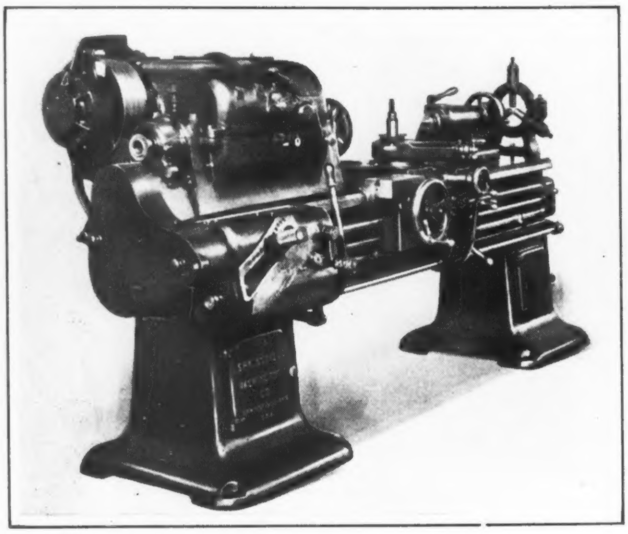


Fig. 1. Springfield Lathe designed for Use in Tool-rooms and Manufacturing Departments

SPRINGFIELD LATHE

An addition to the line of tool-room and manufacturing lathes has recently been placed on the market by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio. This machine is built with a single-pulley drive, as shown in Fig. 1, or with an individual motor drive, as illustrated in Fig. 2. In the latter case, the motor is contained in a housing cast integral with the pedestal at the headstock end of the bed.

The motor is carried on a pivoted base, which may be adjusted to obtain the desired belt tension, the adjustment being made through a screw within the hinged door at the back of the motor housing. The driving pulley runs loose on a wick-oiled bronze bearing, and is equipped with a Carlyle-Johnson friction clutch for transmitting power to the geared head. Either an alternating- or a direct-current motor and a push-button control may be employed.

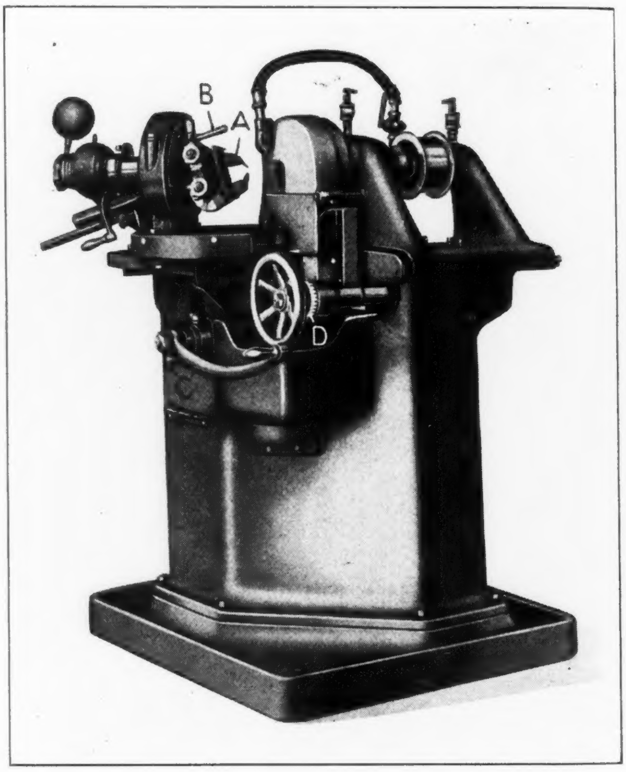
Twelve spindle speeds in geometrical progression are obtained by means of fourteen gears in the headstock. All journals in this head, with the exception of the main spindle journal, are equipped with radial ball bearings, and thrusts are taken by ball bearings. The headstock is oil-tight so that all gears may run in a bath of oil, while the spindle journals are equipped with sight-feed oilers. Operation of the friction clutch on the driving pulley of belt-driven machines may be accomplished through the handle at the right-hand side of the apron or through an overhead push-rod. This clutch pulley is arranged with a self-oiling device that only needs to be supplied with oil once a week. A friction device permits stopping the lathe instantly.

Fig. 2. Motor-driven Lathe with Motor enclosed in Housing cast integral with the Headstock Pedestal

The gear-box is a new feature for a lathe built by the Springfield Machine Tool Co. It provides thirty-six feed changes for cutting threads from 1 to 56 threads per inch, including pipe threads of 11 1/2 and 27 threads per inch. Feeds ranging from 1 inch per 5 1/2 spindle revolutions to 1 inch per 308 spindle revolutions are obtainable. All gears in the feed-box are steel drop-forgings. At the left-hand end of the machine there is a housing which encloses change-gears used in cutting the pipe threads mentioned. Transposing gears may also be used in this case to change the feeds from the English to the metric system. This machine is built in 14-, 16-, 18-, and 20-inch sizes.

TWIST-DRILL POINT GRINDER

A machine for sharpening the points of twist drills having right-hand spiral flutes and two lips is being placed on the market by the Union Twist Drill Co., Athol, Mass. This machine is designed to grind the cutting point of drills with the lips equal in length and with the chisel point coming



Drill Point Grinding Machine built by the Union Twist Drill Co.

in the center of the drill. It is made in two sizes—the No. 2, intended for drills from 1/4 to 3/4 inch, inclusive, and the No. 3, for drills from 5/8 to 2 inches, inclusive.

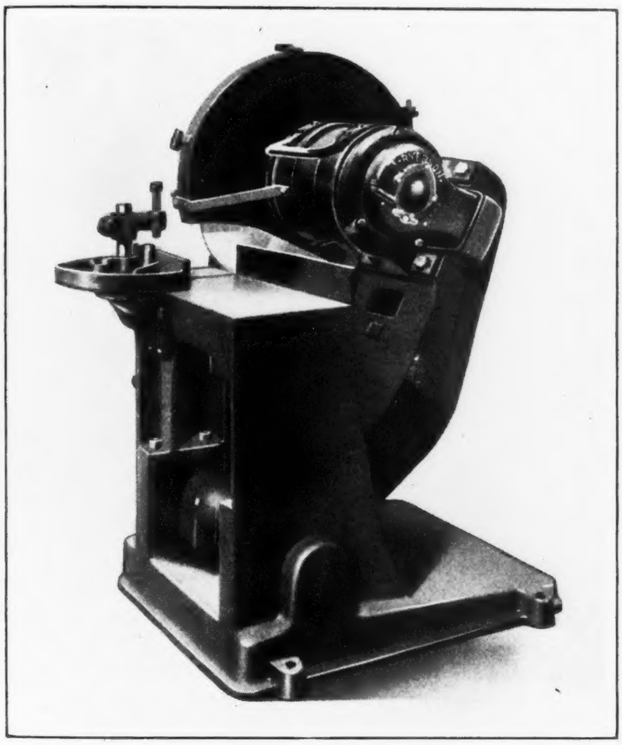
The drill is held by a two-jaw chuck *A*, which is operated by handle *B*. A rapid movement is given to the chuck jaws so as to reduce the time required for chucking the work as much as possible. The chuck jaws are adjustable laterally to give the same clearance angle for drills of different diameters, a graduated plate on the upper jaw showing the setting for the different diameters. Various clearance angles are obtained by adjusting the jaws vertically. When assembled, the machine is adjusted to give a clearance angle of 12 degrees, which has been found satisfactory for general work. The chuck spindle has a rotary movement of about 110 degrees, which can be varied by adjusting screws.

The work-spindle is carried in a housing that is adjustable to give various included angles of the drill points, ranging from 90 to 118 degrees. When it is assembled, the machine is set to give a 118-degree included angle of the point. The work-spindle is carried by a slide operated through a hand-lever *C*, which moves the point of the drill across the face of the grinding wheel. This slide travels on hardened and ground roller bearings.

The grinding wheel is of the ring type, 8 inches in diameter, and is held by means of a flange which is clamped to the end of the wheel-spindle. There is an adjustment of 4 inches to compensate for wear of the wheel and to enable the wheel to be moved to the correct position in relation to the drill. A graduated collar *D* on the adjusting screw provides a means for moving the wheel into the same position for grinding both lips of a drill. A pump and tank, with suitable piping, are provided to supply a sufficient flow of water to the wheel, and the machine is equipped with adequate water or splash guards. A diamond-holder is clamped in the chuck jaws in the same manner as the drill, for truing the wheel when necessary. This method of truing insures that the cutting face of the wheel will be parallel with the travel of the drills when they are held in the chuck. The No. 2 machine weighs about 1580 pounds, and the No. 3 machine, 1850 pounds.

RYERSON HIGH-SPEED FRICTION SAW

Friction saws built in the past by Joseph T. Ryerson & Son, Inc., 16th and Rockwell Sts., Chicago, Ill., have been used mostly in plants where a large quantity of steel is

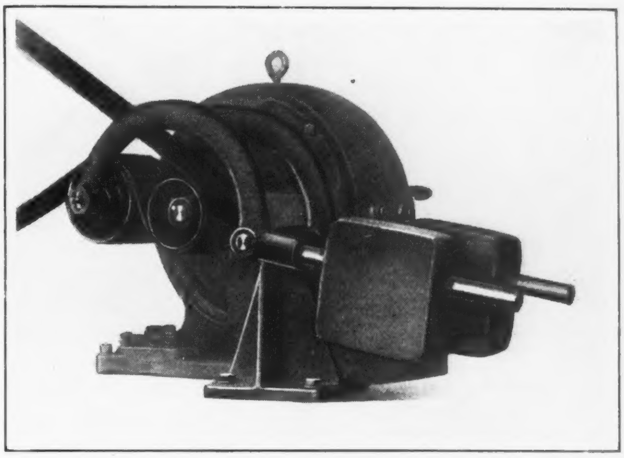


Ryerson High-speed Friction Saw for cutting Small-sized Stock

cut. To meet the requirements of all shops where the smaller bars, structural shapes, and pipe must be cut for fabrication, this company has recently brought out a No. 0 high-speed friction saw which occupies a floor space of only 28 1/2 by 36 inches.

This saw is small enough so that it can be easily moved about the shop, and it has a capacity for cutting 8-inch, 25 1/2-pound I-beams, 8-inch channel irons, 4-inch pipe, 1 1/2-inch round bars and 1 1/4-inch square bars. I-beams of the size mentioned are cut in a fraction over 1 minute, and 1 1/2-inch round bars, in about 1/4 minute.

The saw operates on the same principle as the larger sizes, and is said to give a true cut without distortion. The blades are 24 1/2 inches long by 1/4 inch wide, and are mounted directly on a 10-horsepower ball-bearing high-torque motor, built especially for friction-saw duty. Feeding of the blade through the stock is accomplished by hand. The blade may be water-cooled if desired; however, on the smaller sizes of work, the saw can be operated satisfactorily without using water.



Automatic Belt Contactor manufactured by the T. B. Wood's Sons Co.

U. G. AUTOMATIC BELT CONTACTOR

Tractive effort in pulley drives is increased by wrapping the belt around the pulleys to increase the arc of contact, and not by setting up heavy and destructive initial belt tension. The U. G. automatic contactor for belt drives, now being placed on the market by the T. B. Wood's Sons Co., Chambersburg, Pa., is designed to give an increased arc of contact and a reduction in belt tension. There is a constant tension on the slack side of the belt that is not more than one-half the tension of an open belt at work. This constant tension maintained on the slack side as the load increases or decreases is the result of the pulley and arm design and the proportioning of the weight. The contactor pulley automatically swings against the belt between the driving and the driven pulley, as illustrated.

It is stated that short-center drives often considered impossible, and ratios of pulley diameters said to be impracticable, may be used by the aid of this contactor; that the contactor saves belting, because the amount required for a drive is much less than with an open-belt drive; that it saves floor space by permitting the setting of the motor pulley close to the driven pulley; that it saves bearings by reducing the belt tension and therefore the bearing strain and friction; that it saves motor costs by permitting the use of high-speed motors; and that it saves power by reducing the bearing strains and increasing the arc of contact.

ROSS WHEEL-TRUING TOOL

A wheel-truing tool that is claimed to produce a finish equal to that obtained with a diamond, and yet effect non-diamond dressing economies, has been brought out by the Ross Mfg. Co., Cleveland, Ohio. The tool as made at present is applicable to Norton 6-, 10-, 14-, and 16-inch, and type B model 81 machines; Landis 6-, 10-, 14-, 16-inch machines; and Brown & Sharpe 10-, 11-, and 12-inch machines. Additional

Ross Truing Tool for Grinding Wheels

models are being developed for machines used for grinding crankshafts, camshafts, axles, and similar parts.

The main point of difference between this "Super" tool, as it is called, and others of the Ross line, is the use of an abrasive wheel for the cutting medium instead of a steel barrel or disks. The abrasive wheel is 5 inches in diameter and 1 1/4 inches wide. It operates against the grinding wheel at an angle of 10 degrees, and is held in this position by a set-screw which engages an aligning slot in the holder shank. This angle and the special composition of the abrasive wheel are said to result in the removal of a loaded grinding wheel surface without blunting the fresh grains underneath it, and thus to insure maximum production per dressing of a wheel.

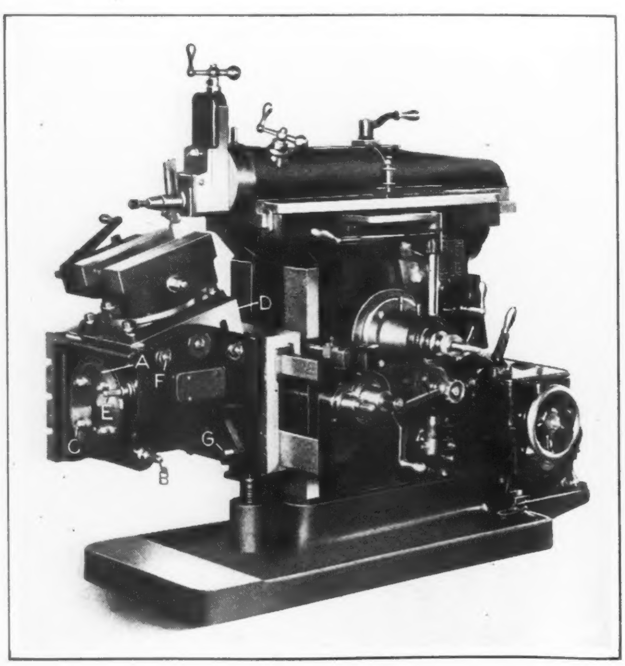
The bracket of the tool is clamped to the table of the grinding machine. The shank of the wheel-holder sets into the bracket at right angles to it, and is held in position by two cap-screws. A steadyrest screw passes through the wheel-holder and bears against the grinder table to prevent vibration. The unit is used in the same manner as other dressers, but less care is needed than with a diamond dresser.

UNIVERSAL SHAPER TABLE

An Averbeck universal table, designed to meet the needs of the tool-room, has been developed by the Steel Products Engineering Co., Springfield, Ohio, for application to the 20- and 24-inch shapers built by this company. The table is supported for the full length by a heavy trunnion cast integral with the apron, as shown in the illustration. A graduated plate *A* indicates the swivel setting of the table, the setting being obtained by applying a crank to shaft *B* which actuates worm-gearing. Four clamping studs *C* are used to maintain the setting.

The table has two working surfaces, generous in size, one of the tops being solid, as on the ordinary shaper table, while the other top *D* is of a tilting type, set well within a rigid body. There is a movement of 16 degrees above or below center for top *D*, and it is graduated on one side to enable accurate settings to be made in this direction. Positioning of this top is obtained by means of a screw and sliding block, operated by applying a crank to shaft *E*. It is locked in any desired setting by means of two clamping bolts *F* which pass through the table near each end and provide the required rigidity.

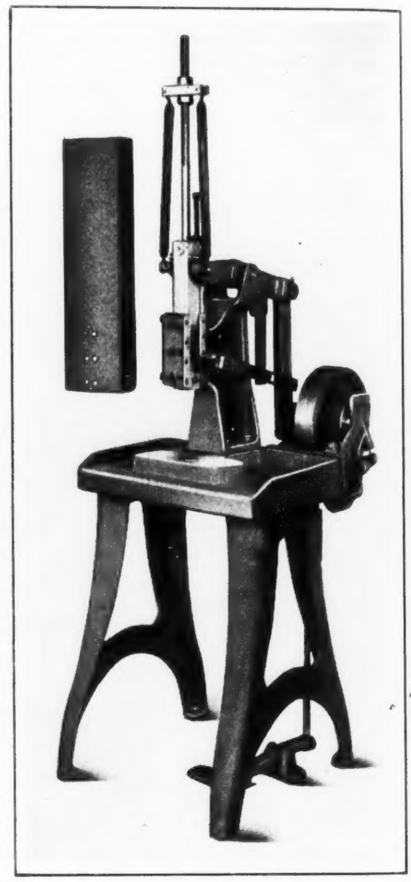
Another feature of this table is the method of locating it in the two horizontal positions. This is accomplished by using a hardened and ground locating plug *G*, which is mounted in the swiveling frame. The plug passes through the apron to permit quick settings, and prevents any inaccuracy, such as is frequently caused by chips or other foreign matter lodging on an open locating block. The apron and other members are generously proportioned to eliminate the need for an outer support.



Universal Table designed for Use on Averbeck Shapers

TAYLOR & FENN POWER SPRING PRESS

Several types of foot-operated, uniform-blow spring presses built by the Taylor & Fenn Co., Hartford, Conn., were described in April MACHINERY. The same company has now brought out a power-operated spring press of the design here illustrated. As with the other types, this press delivers a uniform blow, regardless of the thickness of the work. The blow is controlled entirely by springs, which are readily set to give a blow of any pressure. Set-ups are easy, because there are no fine adjustments. The machine is intended for the lighter classes of work, such as are performed on drop-hammers and ordinary power presses.



Taylor & Fenn Power-operated Spring Press

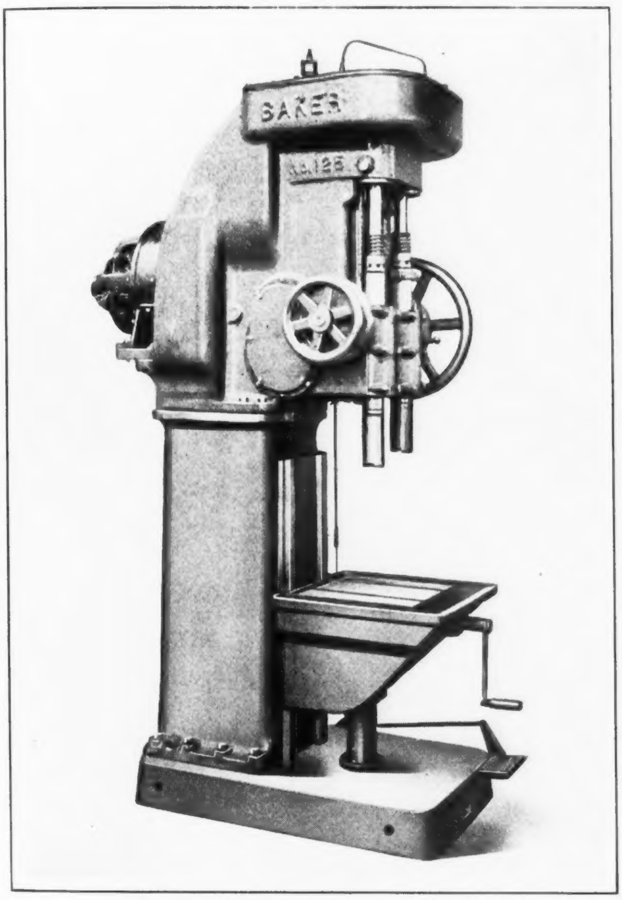
A safety clutch is provided to make the machine stop automatically after each stroke, even if the operator continues to hold down the treadle; however, the press can also be set to give a complete blow when desired. The illustration shows the No. 12 single-acting press, but the same machine can be furnished with a double action, which permits holding two or more pieces together when staking, riveting, embossing, or similar work is being done. The possibility of adjusting the pressure constitutes an important feature of the press. A few of the important dimensions are as follows: Stroke, 3 1/4 inches; maximum distance from bed to ram, 7 1/4 inches; diameter of hole in ram, 3/4 inch; depth of throat, 4 inches; size of bedplate, 12 by 5 inches; and weight, about 550 pounds.

BAKER DOUBLE-SPINDLE DRILLING AND BORING MACHINE

A No. 125 single-purpose drilling and boring machine equipped with two spindles has recently been brought out by Baker Bros., Inc., Toledo, Ohio. It is built with a self-contained motor drive only, and with a fixed center distance between the two spindles. This center distance is 9 1/2 inches on the standard machine, but can be altered within the limits of the machine. A plain table may be used for such work as connecting-rods, brackets, etc., or a circular indexing table for consecutive operations such as rough- and finish-boring or drilling and reaming. The spindles can be adapted to drive multiple heads, provided with a stop for facing accurately to a predetermined depth and equipped with other Baker attachments. It has ample capacity for

driving high-speed drills up to 1 3/4 inches in both spindles, to the limit of their efficiency in steel.

The drive is direct-geared from the motor, the gears being made of alloy steel and hardened. As the machine is essentially production equipment, one speed and one feed are furnished. In the speed gear train, the crown gears on the spindle are readily removable, and the speed of either spindle can thus be changed independently of the other. This arrangement permits the use of tools of different diameters in the two spindles, and the proper ratio of speed between drilling and reaming operations, or roughing and finishing operations. The ratio of the drive from the motor can also be readily changed to alter the speed of both spindles. Slip change-gears are provided for the feed train, and these, in combination with single-, double-, or triple-lead worm-gears, give a range of feeds beyond ordinary requirements.



Baker Single-purpose Drilling and Boring Machine equipped with Two Spindles

The spindles are slotted across the end for driving heavy boring and facing tools; they are fitted with a cross drift for holding heavy tools, and provided with a hollow setscrew to prevent light tools from dropping out. All controls are located in the most logical position to minimize effort on the part of the operator. The feed is engaged by means of the Baker patented foot-treadle, leaving both hands of the operator available for chucking the work. Disengagement of the feed is accomplished by means of an adjustable trip on the quill, the spindles being returned by counterweights after the disengagement. The weight of this machine furnished with a plain table and a 7 1/2-horsepower motor is about 4200 pounds.

"LITTLE GIANT HICYCLE" PORTABLE ELECTRIC TOOLS

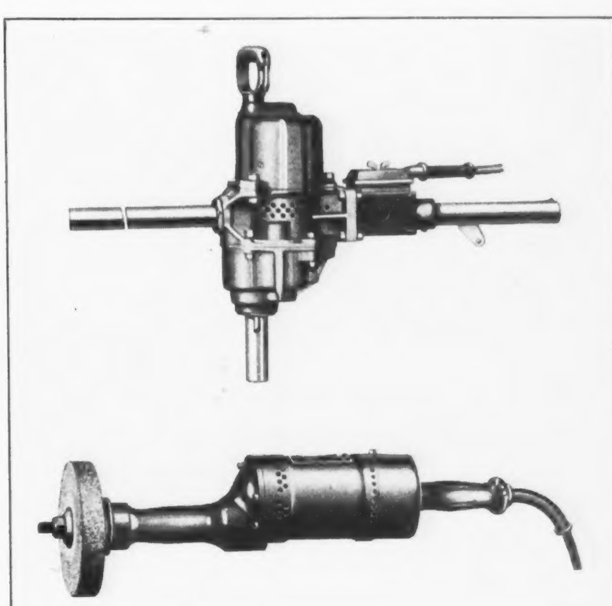
The advantages claimed for a new line of portable alternating-current electric tools recently developed by the Chicago Pneumatic Tool Co., 6 E. 44th St., New York City, are high power, light weight, and durability. A reamer and grinder of this line are shown in the accompanying illustration. It is pointed out that the induction motor, which operates on two- or three-phase alternating current, requires less attention than an equivalent direct-current motor, largely due to the absence of a commutator and brushes, as well as to the more constant speed. The secondary element, usually the rotor in the induction motor, cannot be burned out, whereas both the armature and field coils of the direct-current motor are subject to this damage.

These advantages also apply to the smaller induction motors used in portable electric tools. However, their chief drawback in such tools, as pointed out by the Chicago Pneumatic Tool Co., has been that on the standard power lines, where 60-cycle current is available, the maximum rotor speed with a two-pole motor is 3600 revolutions per minute, whereas much higher speeds are common with direct-current tools. This drawback of the induction motor has been overcome in the new "Hicycle" tools.

Quoting the manufacturer of these tools: "The power developed under load by any portable tool with a given size of armature (assuming that the best design of winding has been applied) depends upon the speed under load and is in almost direct proportion to the speed. For instance, assume that a drill or grinder of a given size has an armature speed, without load, of 11,000 revolutions per minute and a full load speed of 4800 revolutions per minute. If by any means the speed at full load can be increased to 9600 revolutions per minute, the power of the tool would be doubled. The limiting speed in a series-wound direct-current motor is, of course, the free speed, and in the case of a drill or grinder of said given size of armature, this could not be safely increased to the extent required to give a loaded speed of 9600 revolutions per minute.

"Now let us consider the alternating-current induction-type tool with all of its inherent advantages. At 60 cycles the maximum speed is 3600 revolutions per minute (with a two-pole motor.) At 180 cycles the speed of the two-pole motor will be 10,800 revolutions per minute, and at full load, the speed will drop approximately 8 per cent, giving a speed of 9936 revolutions per minute. It will readily be seen that while the free speed of the 180-cycle tool is no higher than the drill or grinder of the size in mind in making this comparison, the loaded speed is more than double, so that more than twice the power will be developed with the same size rotor or armature. As compared with the 60-cycle induction motor, practically three times the power will be developed."

To operate the "Hicycle" tools, a special generator is required to furnish 180-cycle, 220-volt, three-phase current,



"Little Giant Hicycle" Reamer and Grinder

which has been adopted as standard. This frequency lends itself well to a 60-cycle induction motor drive, being a multiple of 60 cycles, so that direct-connected generator sets can be supplied economically. Maintenance costs are reduced materially because of the advantages mentioned and the use of ball bearings throughout.

OLSON INDICATING SNAP GAGE

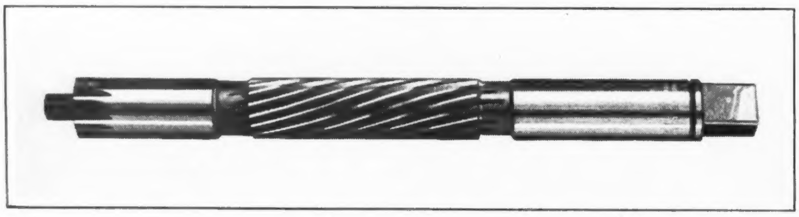
A new type of indicating snap gage has recently been placed on the market by the Olson Tool & Mfg. Co., 6545 Carnegie Ave., Cleveland, Ohio. On this gage there is a dial indicator mounted in such a position that it meets the line of vision at any angle at which the gage may be used. The construction may be clearly seen in the accompanying illustration. With a gage of this type, an operator can readily determine just when to stop removing metal from a part, as the gage measures the amount left to be removed.

Olson Indicating Snap Gage

A slight pressure is applied on the push-button located below the indicator, to raise the movable anvil before the gage is applied to the work, this feature eliminating wear on both the movable and the fixed anvils. Movements are transmitted from the movable anvil to the indicator by means of a lever having a ratio of 10 to 1. The dial reads to 0.0001 inch. Each size of gage has a range of 1/2 inch, the adjustment being made by moving the lower anvil. The latter is provided with an elevating screw and a positive locking device. The gage can be forced 0.0001 inch over or under the size it is set for and, consequently, an operator of ordinary skill is able to make close measurements. This gage is made in sizes up to 18 inches.

"RED-LINE" EXPANSION REAMERS

The principal feature of the "Red-Line" expansion reamers manufactured by the Modern Reamer Specialty Co., Millersburg, Pa., is the large number of flutes provided. The number of flutes ranges from six on the small sizes to thirty or more on the large sizes, the reamers being made in many different sizes from 1/4 to 3 inches in diameter. It is claimed that the greater number of flutes increases the cutting efficiency of the tools, lengthens their life, and eliminates chatter. There is sufficient space between the flutes to afford ample chip clearance. Another advantage claimed for these reamers is that the method of expansion insures accuracy of the settings. As will be seen from the accompanying illustration, the flutes are helical.



"Red Line" Piston-pin Expansion Reamer

COMBINATION SHEAR, ROD-CUTTER AND PUNCH

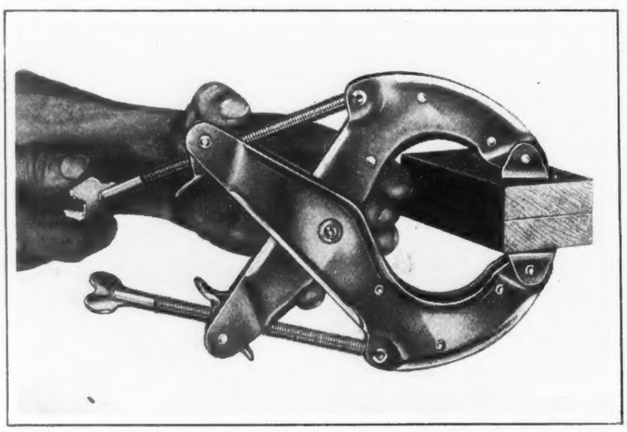
The latest addition to the line of hand-operated tools manufactured by the Bench Machine Tool Co., 220 N. 13th St., Philadelphia, Pa., comprises the No. 3 combination shear, rod-cutter and punch here illustrated. This device is designed to be mounted on a low bench, although a stand can be furnished or a truck, if the tool is to be portable. It has a capacity for cutting flat bars up to 5/16 by 2 1/2 inches, and square or round bars up to 5/8 inch, while holes up to 3/8 inch can be punched in 3/16-inch steel plate. The throat of the punch is 2 inches deep. In operation, the work is simply placed in the device and the handle pulled, a length gage permitting repetition work to be performed within close limits.

Combinat'on Shear, Rod-cutter and Punch made by the Bench Machine Tool Co.

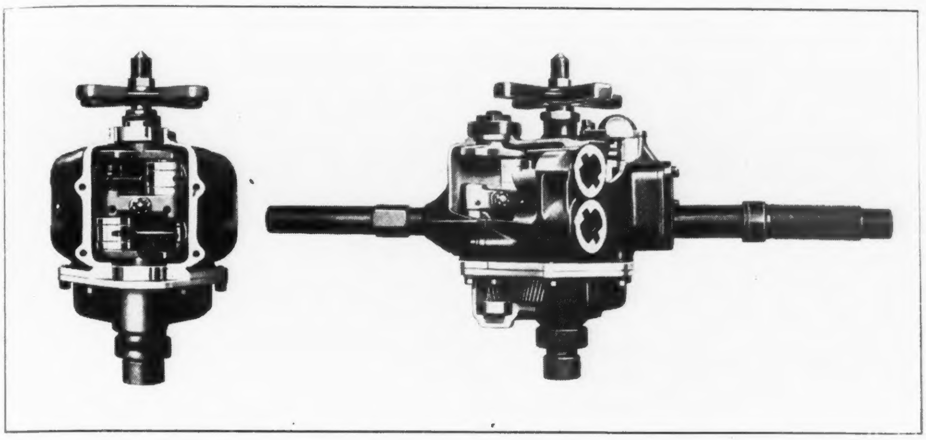
The cam action and leverage construction make the machine easily operated with but one pull of the handle for cutting each piece of stock or punching each hole. The shear and punch are placed at the front for accessibility. All bar dies are interchangeable, so as to readily permit cutting various bar sections and structural shapes. These dies are so arranged that they confine the metal and eliminate distortion; hence the ends are cut clean and square. The dies and shear blades are made of a special alloy tool steel, hardened and ground, and all other steel parts are hardened.

QUICK-ACTING CLAMP

A clamp that may be used for a large variety of purposes is now manufactured by the Practical Die & Specialty Mfg. Co., 2614-24 W. 48th St., Chicago, Ill. From the accompanying illustration it may be seen that the construction consists



Clamp manufactured by the Practical Die & Specialty Mfg. Co.



Ingersoll-Rand Pneumatic Drill equipped with a Speed Governor

primarily of two hinged jaws, each of which is made up of two steel drop-forgings that are reinforced at the gripping ends by a piece rivetted between them. To each jaw there is attached a screw arranged to swivel and to pass through a swivel nut in the back end of the opposite jaw. Both nuts are of an ingenious construction that permits them to firmly grip the threads of the screws when it is desired to tighten the jaws on parts, or to clear the screw threads when it is desired to release the clamp from the parts. When the nuts clear the threads, they can be quickly slipped along them for opening or closing the jaws. The clamp is manufactured in three sizes.

HOERL FRICTION CLUTCHES

A new line of Raybestos-covered friction clutches is being introduced to the trade by the Wolf Co., Chambersburg, Pa. These "Hoerl" clutches may be made as a coupling or with a sleeve for a pulley. They are carried in stock in different sizes having a rating of from 4 to 30 horsepower at 100 revolutions per minute, and are made to order in additional sizes up to one having a capacity for transmitting 700 horsepower at 100 revolutions per minute. The design of these couplings is simple; they are composed of only eight parts, consisting of two rings, two levers, a shell, a cone, a collar, and a plate.

The clutch is engaged by sliding the cone along the shaft, which causes the levers to force the Raybestos-covered rings against the inside of the shell rim. Engagement can be accomplished gradually or quickly, and a clean-cut release is obtained as soon as the lever is operated for disengagement. This release is obtained regardless of the speed of operation, because the action of the levers and the cone pulls the rings away from the shell. All parts of the clutch are readily accessible after removing a set collar. A considerably larger friction surface is provided on the clutches than is necessary to develop the rated horsepower. This design naturally reduces the friction per square inch and gives the clutch a longer life. As all points of the friction surface are equidistant from the center of the clutch, the wear on the lining is uniform. When adjustment is needed, a slight turn of two screws gives the desired result. The outside diameter of the 4-horsepower clutch is 6 3/4 inches, and that of the 700-horsepower coupling, 51 3/8 inches.

INGERSOLL-RAND PNEUMATIC DRILLS

One of the main features of a new line of four-cylinder pneumatic drills recently brought out by the Ingersoll-Rand Co., 11 Broadway, New York City, is the provision of a speed governor that automatically prevents "racing" the drill beyond a safe working speed. The governor also saves on air consumption, reduces wear and tear of the drills, and avoids burning taps and reamers. These drills are made both in reversible and non-reversible styles.

Another feature is that renewable liners of a special steel are fitted into the cylinders so that the cylinder case proper never wears out. It is said that this construction also makes it practically impossible for a cylinder to become dented or for a piston to stick. There is a space between the cylinder liner and cylinder case walls that also prevents sticking of the piston. The crankpins are fitted with a sleeve which is held stationary on the crankpin, so that all wear takes place on the sleeve. This sleeve can also be replaced when it becomes worn. Lubrication of the crankpins is accomplished from the inside, as well as from the outside, holes being drilled through the cranks, as in automobile engines.

The main valve is air-balanced so as to avoid wear on the bushing, and it is timed by gears. The gearing is of the helical type, the crank pinion being renewable independently of the crank. Solid-end connecting-rods are used. The complete crankshaft, with the pistons and connecting-rods, can be assembled outside of the case and inserted as a unit.

LUEHRS DRILLING AND TAPPING MACHINE

A semi-automatic machine recently developed by the Luehrs Co., 118 St. Clair Ave., N.E., Cleveland, Ohio, is shown in the accompanying illustration tooled up for drilling, counterboring, and tapping gas-stove cocks. The machine may also be used for performing operations on a large variety of iron, steel, brass, or aluminum pieces. It is equipped with two independent motor-driven drill spindles and two tap spindles. A twelve-sided turret, which revolves on a horizontal axis, carries twenty-four jigs for holding the

Luehrs Semi-automatic Machine designed for Drilling, Tapping, and Similar Operations

work. Mounted above the turret is a work hopper which supplies two chutes, one on each side of the turret. The operator stands directly in front of the machine, and uses both hands to take pieces of work from each feed-chute and place them in the jigs as the jigs are fed past the chutes.

The turret is indexed by a continuously revolving screw on the main feed-shaft, which operates on pins secured to the face of the index-plate, the latter being keyed to the turret shaft. The main feed-shaft also carries a face-cam, which actuates a lever to insert and withdraw a locking pin that seats in hardened and ground bushings in the periphery of the index-plate. The locking pin is withdrawn to permit the turret to revolve from one position to the next, and then reseated to hold the turret firmly while the tools are operating. The work is automatically clamped in the jigs for the operation, and is again automatically released after it has been performed.

The main driving motor is of 3/4 horsepower capacity, and runs at 1800 revolutions per minute. It is mounted on a tripod bolted to one side of the machine and transmits its power through a flexible coupling to the main driving shaft. This motor is controlled by means of a push-button, which operates through a "Thermaload" starter. The main driving motor also operates the two tap spindles through bevel gears, while the drill spindles are driven by individual 1/4-horsepower motors running at 3600 revolutions per minute. The reciprocating motion of the drill and tap spindles is obtained through a double-faced cam which operates a set of rocker arms. Each drill-spindle motor carries a flywheel to supply the additional energy required when a counterbore is taking its maximum cut.

The chief feature of the machine is that the main frame, turret, drilling and tapping sub-assemblies, oil guards, hopper, and chip-pan are all built up of steel plates and structural bars, welded together electrically. There is almost an entire absence of castings in the construction.

MICRO DOUBLE-HEAD ALIGNING GRINDER

A model EG double-head machine has recently been developed by the Micro Machine Co., Bettendorf, Iowa, for grinding parts where the alignment of holes is of particular importance. This machine will also face-grind work at right angles to the bore. The maximum length of work that can be mounted in the machine is 5 feet 6 inches, and on work of this length, bearings may be ground 6 inches deep. As the length of the work decreases, the grinding depth can be increased at either end by changing the length of the spindle. Thus, if the work is 4 feet 6 inches long, spindles can be furnished to grind 12 inches deep at either end. The diameter of holes in all cases can vary from 1 1/8 to 15 inches.

Work-holding angle-plates with independent vertical adjustments are provided. They are mounted on a cross-slide sub-plate which is equipped with a graduated feed-screw and a taper take-up gib. The entire fixture and sub-plate are mounted on the main table. Quick start and stop controls are furnished, and these can be operated from either end of the machine. There are five table feeds to suit various depths of cut and hand and rapid-power feeds.

The headstock main bearings can be operated independently of each other. They are controlled by a friction clutch through an operating lever, conveniently located on the front of the machine, and are equipped with handwheels to permit quick centering. Eccentric feeds, fine or coarse, may be operated while the main bearing is running.

The machine may be used either for wet or dry grinding. All units are equipped with either force-feed or grease-gun lubrication. The machine embodies the same features as the single headstock machines built by this company. It occupies a floor space of 5 feet 9 inches by 13 feet 3 inches, and weighs about 13,000 pounds, less the motor.

GEAR RESEARCH

In a letter to the editor, Otto M. Burkhardt, research manager of the Society of Automotive Engineers, points out the desirability of cooperation between the special research committee on gears of the American Society of Mechanical Engineers, and the Society of Automotive Engineers, with a view to solving certain problems connected with gearing, for which the gear testing machine built under the auspices of the committee mentioned would be suitable. In this connection, Mr. Burkhardt points out that American automobiles, if kept in good repair, compare in quiet running very favorably with most European cars. This reputation has been acquired against considerable odds, such as the abundance of well-trained mechanics that are at the command of the European manufacturer. Such a state of affairs can be considered as a recompense for the painstaking development of our production methods. Accurate machining is particularly superior to hand finish in the case of gears. Therefore, every effort should be made by American automobile engineers to study all phases of gearing in an effort to find further improvements.

To obtain satisfactory gears, many conditions must be observed. For instance, the tooth flanks must be kept accurate within very narrow limits. Instruments for measuring and graphically recording various kinds of errors have been devised and are in use. However, they do not always bring unqualified success. They serve to reveal certain classes of errors which have been found the greatest offenders from the viewpoint of noise, but as a rule the measuring instruments in common use give no information on the effect of errors on shocks, strength, uniformity of motion, and the length of life of gears.

It is an established fact that at about 1000 feet per minute pitch velocity, gears whose inaccuracies of spacing do not exceed 0.001 inch will carry twice the load of those having inaccuracies of spacing of 0.006 inch. It is very doubtful if any consideration has been given to this fact during the later developments in transmission gearing. For instance, in many cases some improvement has been obtained by merely grinding the constant-mesh gears; for this reason, the low and intermediate gears are left as they come from the heat-treatment department. This is a good practical solution, but the important advantage that ground gears for a given load and length of life can be made smaller than rough gears has usually been neglected. The reason for this is obviously the fact that there are not a sufficient number of facts available on the important relation between speed and load impacts, as well as inaccuracies and load impacts. If we consider that smaller gears permit of smaller centers, lower pitch line velocities, and smaller cases it will soon be appreciated that much can be gained by utilizing, to the limit, every possible advantage that can safely be engineered into the design.

These possibilities open up a field for new research, and it is gratifying to note that work has already been started by a special research committee appointed by the American Society of Mechanical Engineers. The purpose of this committee is to determine the effect of varying degrees of tooth and space accuracy and varying velocities on the strength of gear teeth. The committee has designed and built for the execution of its work an ingenious testing machine which is now installed at the Massachusetts Institute of Technology. The information gained from tests with this machine will also be essential to the solution of the noise and wear problem.

It is hardly necessary to point out that scores of formulas for the calculation of gears are now in existence, but none takes adequate care of the effect on strength of speed and the load increments due to errors in tooth form. The above-mentioned machine lends itself excellently for a study of these various factors. The machine is built for gears of relatively large pitch diameters, but it is believed that some data and information of interest and value to automotive engineers will be obtained from it.

PERSONALS

T. V. BUCKWALTER, who has been chief engineer for the Timken Roller Bearing Co., Canton, Ohio, was made vice-president in charge of engineering at the July meeting of the directors of the company.

T. J. LITLE, JR., chief engineer of the Lincoln division of the Ford Motor Co., and now first vice-president of the Society of Automotive Engineers, was nominated for election next January to the presidency of the society for 1926 at the semi-annual meeting of the organization.

C. W. MOORE, with office at 1523 Candler Bldg., Atlanta, Ga., represents the Goddard & Goddard Co., Detroit, Mich., manufacturer of milling cutters, in the southeastern territory covering North Carolina, South Carolina, Georgia, Florida, Alabama, and Tennessee east of the Tennessee River.

CLARK H. MINOR, former vice-president of the International General Electric Co., has been elected president to succeed ANSON W. BURCHARD, who had been both president and chairman of the board. Mr. Burchard will continue as chairman, but had asked to be relieved of some of the duties of his double position.

JOHN D. HURLEY, president of the Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill., manufacturer of "Thor" pneumatic tools and electric drills, sailed from New York City on July 1 on the *Aquitania* for an extended trip throughout continental Europe. Mr. Hurley will visit various "Thor" agencies and branch offices throughout Europe.

ROBERT J. ANDERSON has opened a consulting metallurgical engineering office at 221 Amber St., E. E., Pittsburg, Pa., confining his practice to aluminum and aluminum alloys, in which field he offers a general consulting engineering service in the metallurgy, production, and application of this metal and its alloys, covering all the phases from the raw materials to the finished products.

FRANK A. SCOTT, president of the Warner & Swasey Co., Cleveland, Ohio, has been awarded a certificate by the War Department for notable service in connection with the procurement of supplies during the World War. Colonel Scott was chairman of the General Munitions Board, and was first chairman of the War Industries Board. He is now chief of the Cleveland District Ordnance Office.

ROBERT MILLER has been appointed manager of the Rocky Mountain sales district of the General Electric Co., succeeding HARRY D. RANDALL, who is on leave of absence because of ill health. B. J. WHEATLAKE succeeds Mr. Miller as local office manager at Salt Lake City, and Mr. Randall has been assigned to special duties at the general office of the company in Schenectady. Mr. Miller's headquarters will be in Denver, Col.

ARLINGTON BENSEL, who for twenty years has acted in the capacity of vice-president and sales manager of the Driver-Harris Co., Harrison, N. J., has engaged in business as exclusive sales agent for Victor Hybinette, Wilmington, Del., manufacturer of "Hybnickel" alloy products. Mr. Bensel will have offices at 300 Madison Ave., New York City. The "Hybnickel" alloy products find application in various forms for thermal, chemical, and electrical uses.

COLONEL H. C. BOYDEN, of Chicago, national lecturer for the Portland Cement Association on subjects pertaining to the proper use of concrete, has been appointed dean of the engineering department of Ohio Northern University, Ada, Ohio. He assumes his new duties on September 1. Colonel Boyden is a graduate of Worcester Polytechnic Institute, class of 1894, and a member of the American Society of Civil Engineers and the Society of American Military Engineers.

HARRY D. MCKINNEY has been elected second vice-president and general sales manager of the Driver-Harris Co., Harrison, N. J., manufacturer of special alloys in the form of castings, wire, rods, sheets, strips, and strands, for electrical, mechanical, and chemical uses. Mr. McKinney went to the Driver-Harris Co. in 1918 as district sales manager of the New England territory, in which capacity he served until 1920, when he was transferred to the Chicago sales office as manager. Previously Mr. McKinney was employed by the Westinghouse Electric & Mfg. Co. in various capacities, both in the shops and in the sales department. He therefore brings to his present position a broad training and experience both in the electrical field and in the alloy, wire and casting fields.

JOHN F. SCHURCH has been elected president of Manning, Maxwell & Moore, Inc., New York City, manufacturers and distributors of machine tools and railway and industrial equipment, succeeding J. M. DAVIS, who recently resigned to become president of the Delaware, Lackawanna & Western Railroad. Since 1922 Mr. Schurch has been vice-president in charge of the western sales of Manning, Maxwell & Moore. He graduated from the University of Minnesota in 1893, and entered the service of the Minneapolis, St. Paul & Sault Ste. Marie Railroad the same year. In 1905 he left this railroad after having attained the position of chief clerk to the vice-president, and from 1905 to 1914 was associated with the Railway Materials Co., of Chicago. In 1914 he was elected vice-president of the Damascus Brake Beam Co., with offices in Cleveland, and later in the year was elected president of the company, from which position he resigned to become vice-president in executive charge of the Symington Co.

OBITUARIES

GEORGE A. WOOD

George A. Wood, president of the T. B. Wood's Sons Co., manufacturer of power transmission machinery, Chambersburg, Pa., died suddenly at his home in that city from heart failure, June 17, within a few months of being eighty years old. Mr. Wood was born October 9, 1845, on a farm near New Kingston, Cumberland County, Pa. At the age of sixteen he left the Chambersburg Academy and went to work in the foundry and machine shop which his father had established some years earlier in Chambersburg. From that time on he was uninterruptedly connected with this business—now the T. B. Wood's Sons Co.—for a period of more than sixty-three years, which is a record seldom paralleled in the average business career.

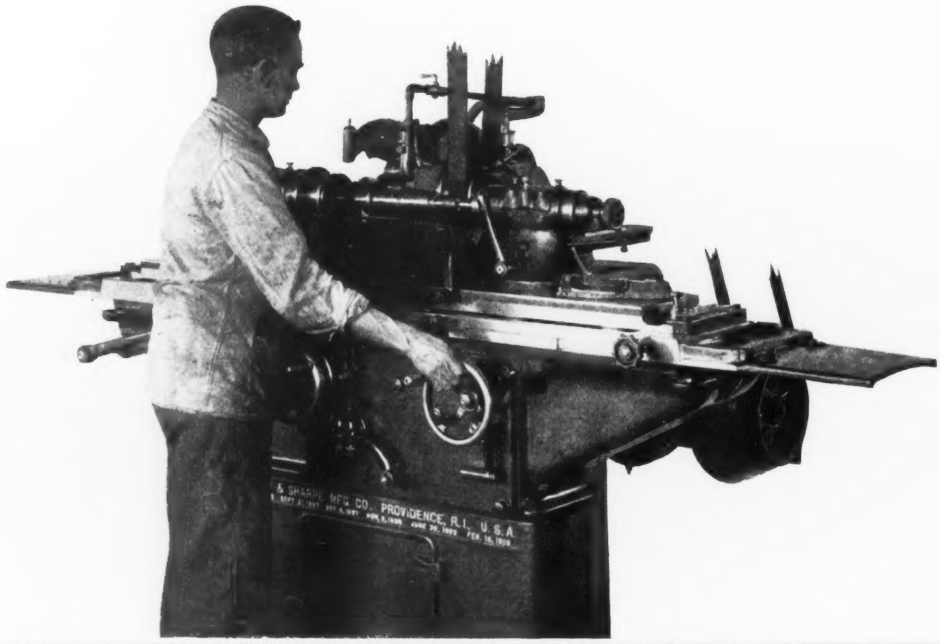
The life of Mr. Wood was closely interwoven with the development of the shop he entered as an apprentice and which grew into the large business of which he was the head for many years. He was associated in an official capacity with the firm for more than fifty years, his father having taken him into the business as a partner in 1868, and he assumed the duties of president and general manager when the firm was incorporated somewhat more than twenty years ago. During his lifetime Mr. Wood saw the shop grow from a small establishment to the present large plant, and from an organization numbering a score of employes to one employing several hundred men. Mr. Wood was also president of the First National Bank of Chambersburg for twenty years.

In 1870 he married Katherine M. Spangler of Chambersburg, who, with three sons, Charles O., Theodore B., and George Herbert Wood, all of Chambersburg, Pa., and a daughter, Mrs. Bertha K. Mitchell, of Princeton, N. J., survives him. Two brothers, T. M. Wood of Chambersburg, Pa., and Charles H. Wood of Anthony, Kan., also survive him.

FREDERICK FERDINAND FUESSENICH, chairman of the board of directors of the Hendey Machine Co., Torrington, Conn., died at his home in that city Sunday, June 28, at the age of seventy-seven. Mr. Fuessenich had been associated with the Hendey Machine Co. for over fifty years. In 1874 he became a stockholder and director. He served as secretary from 1883 to 1889, as treasurer from 1892 to 1918, and as president from 1907 to 1919 when failing eyesight made it impossible for him to remain active head of the company. His affliction did not, however, diminish his interest in the business and in the everyday affairs of life. In the early days of his business career he always maintained a strong faith in the possibilities of the enterprise with which he was connected, even in times of doubt and discouragement—a faith that later events proved to be amply justified.

HERBERT S. VALENTINE, sales manager of the monorail hoist department of the American Engineering Co., Philadelphia, Pa., and inventor of the "Lo-Hed" hoist manufactured by that company, died at his home in Philadelphia on June 5. Mr. Valentine had more than twenty years experience in the design and manufacture of hoists, having been connected with a number of leading manufacturers in this line in important engineering and executives positions. He was one of the organizers of the Standard Electric Crane & Hoist Co., of Philadelphia, and was chief engineer of that company, when it was taken over in 1922 by the American Engineering Co. It was while he was with the Standard Electric Crane & Hoist Co. that his many years of contact with hoist problems developed into the design of the "Lo-Hed" hoist.

UNIVERSAL GRINDING MACHINES



"What shall it profit—?"

"What shall it profit—?" This is the salient question in the mind of every prospective buyer of Brown & Sharpe Universal Grinding Machines. Profit results from savings.

There is the saving through versatility. The large variety of work produced by the machines reduces equipment costs.

There is the saving from reduced spoilage. The ease and simplicity of control lessen errors.

There is the saving from slow depreciation. The exacting choice of metals, the careful balancing and the painstaking accuracy in building produce long-service machines.

These are merely a few of the savings, those readily evident. Brown & Sharpe Universal Grinding Machines effect many.

Profit results from savings.

The Universal Machines are readily adjustable for grinding all taper angles. The piece shown in the machine above and again below, finished, is an example of the work these machines produce, rapidly and accurately.

Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

Universal Grinding Machines are built in five sizes, from the No. 1, for light work, to the No. 4, a sturdy machine for long pieces.

The No. 138 General Catalog completely describes these machines. Send for a copy today.

BROWN &

TRADE NOTES

LINK-BELT MEESE & GOTTFRIED Co., of San Francisco, Cal., has opened a new branch office at Fresno, Cal. This office will be in charge of Ralph L. Elrod and will be located at 215 Brix Bldg.

ALVORD REAMER & TOOL Co. and A. J. POLK & SON Co., both of Millersburg, Pa., will be known as the ALVORD-POLK TOOL Co., effective July 1, the latter company handling the manufacture and sale of the products of both of the companies mentioned.

STROM BALL BEARING MFG. Co., 4563 Palmer St., Chicago, Ill., has appointed Frank R. Schubert general manager. John Dlesk succeeds Mr. Schubert as works manager, and Lorenz Peterson continues as assistant works manager in charge of production.

HAINES TOOL Co., INC., 6536 Carnegie Ave., Cleveland, Ohio, has been organized for the purpose of reclaiming milling cutters and other tools, and for doing high-grade grinding work. G. L. Haines is president; W. J. Haines, vice-president; and R. M. Haines, treasurer and superintendent.

E. L. ESSLEY MACHINERY Co., 551 W. Washington Blvd., Chicago, Ill., announces that the company has acquired the exclusive agency in the Chicago territory for the sale of the armor plate punches and shears, bar cutters, slitting shears, and beam shears made by the Buffalo Forge Co., Buffalo, N. Y.

EX-CELL-O TOOL & MFG. Co., 1469 E. Grand Blvd., Detroit, Mich., maker of jig bushings and high-speed grinding spindles, has practically doubled its manufacturing floor space and added a considerable amount of modern equipment with a view to greatly increasing the efficiency of its service to its clients. The plant addition is of modern steel sash construction with unusually good overhead lighting.

LINCOLN ELECTRIC Co., Cleveland, Ohio, announces that the firm of Whitman & Brandt, Atlanta, Ga., will represent the company in the state of Georgia, carrying "Stable-Arc" welders and "Linc-Weld" motors in stock. The Clyde Equipment Co., Seattle, Wash., and Portland, Ore., has been appointed distributor for the states of Washington, Oregon, and Idaho.

PITTSBURG GEAR & MACHINE Co., 2700 Smallman St., Pittsburg, Pa., has been appointed by the General Electric Co. exclusive distributor in the Pittsburg district for the manufacture and sale of "Fabroil" and "Textolite" non-metallic pinions. Raw materials will be carried in stock in Pittsburg, enabling delivery of finished gears to be made within two or three days.

THOMSON ELECTRIC WELDING Co., Lynn, Mass., manufacturer of electric welding machines, announces that the company's business in Philadelphia and surrounding territory is now being handled by a direct representative, William T. Ober, located at 2006 Market St., Philadelphia, Pa., the selling arrangements formerly in effect with the Stoer Machinery Co., Philadelphia, having been discontinued.

PRENTISS VISE Co., 106 Lafayette St., New York City, has purchased the Henry Cheney Hammer Corporation of Little Falls, N. Y., and will continue to produce hammers at the Little Falls plant with practically the same personnel as before. Cheney hammers will be sold through the Prentiss Vise Co., and the hammer plant will be operated as the Cheney Hammer Division of the Prentiss Vise Co.

NATIONAL AUTOMATIC TOOL Co., Richmond, Ind., builder of multiple drilling and multiple tapping machinery, has purchased the complete patent, manufacturing, and sales rights of the Minster high-duty drilling machines from the Minster Machine Co., Minster, Ohio. The manufacture and sale of these machines will be carried on in the future at the plant of the National Automatic Tool Co., at Richmond, Ind.

HAMMOND BRASS WORKS, Hammond, Ill., has placed a contract with the Austin Co., foundry engineers and builders, Cleveland, Ohio, for the design and construction of a new brass foundry on Summer St., in Hammond. The new building will be used as a foundry and machine shop. It is 90 by 320 feet, one-story steel construction, monitor type, and contains approximately 30,000 square feet of floor space.

MORRISON MACHINE PRODUCTS Co., Rochester, N. Y., manufacturer of collets and feed chucks of all types, announces that D. G. Anderson has been elected president and general manager, and L. R. Evans, vice-president and treasurer. The company has doubled its plant capacity and greatly increased the stock of standard collets and feed chucks carried, so as to be able to make immediate shipment on practically all standard sizes required.

HOOSICK FOUNDRIES, INC., Hoosick Falls, N. Y., a newly incorporated concern, has purchased the plant of the Walter A. Wood Mowing & Reaping Machine Co., and will operate the machine shops and malleable and gray iron foundries formerly operated by that company. Henry Burden of Cazenovia, N. Y., is president; F. H. Fowler, vice-president and general manager; and William C. Feathers, secretary and treasurer. E. K. McLean, Jr., is sales manager; G. N. Allen, works manager; and George V. Usher, purchasing agent.

WILEY MACHINE Co., 631 E. Slauson Ave., Los Angeles, Cal., is enlarging its plant by adding another unit, thereby doubling its manufacturing capacity. The new building will be 80 by 120 feet, with concrete foundation, cement floors, brick walls, steel sash, wire glass, and a sawtooth design structural steel roof. The shop, which handles jobbing work of various kinds, but specializes in metal stampings and screw machine products, as well as in tools and dies, will have a floor space of approximately 20,000 square feet when the addition is completed.

FEDERAL MFG. Co., Columbus, Ohio, one of the oldest manufacturers of brass goods in the United States, moved its factory and general offices on July 1 to Marysville, Ohio, thirty miles from Columbus, where a large modern plant has been acquired, in which additional machinery and other equipment will be installed to increase the capacity. The name of the company has been changed to the FEDERAL BRASS & MFG. Co., but there will be no change in personnel or organization. Scott Van Etten is secretary and general manager of the company.

BRIDGEPORT BRASS Co., Bridgeport, Conn., has made arrangements with the E. F. Keating Co., 452 Water St., New York City, to handle the sale of "Plumrite" brass pipe in the metropolitan district. The Keating Co. was established in 1885, and has a large sales force covering all the boroughs of New York City, as well as Long Island, northern New Jersey, and all of New York state. This company also has a plant in Hartford, Conn., for the fabrication of piping and tubing of iron, steel, brass, and copper, known as the E. F. Keating Pipe Bending & Supply Co.

SIMONDS SAW & STEEL Co., Fitchburg, Mass., announces that the prizes in the economic essay contest for 1924, offered by Alvan T. Simonds, president of the company, which contest was open to all students in the high schools and normal schools of the United States and Canada, have now been awarded, the first prize of $500 having been won by Aaron Scherwin, of the Alexander Hamilton High School of Commerce, Brooklyn, N.. Y. The Alvan T. Simonds prize contest for 1925 has for its subject "Your Prosperity and Mine." The contest is open to anyone in the United States and Canada. For further information, address Contest Editor, 470 Main St., Fitchburg, Mass.

HALL PLANETARY THREAD MILLING MACHINE Co., Philadelphia, Pa., announces that the company's name has been changed to the HALL PLANETARY Co. A new factory has just been completed at Fox St. and Abbotsford Ave., Philadelphia, in which the most modern and advanced ideas in factory construction have been incorporated. The first section of the new factory, now completed, is 100 by 150 feet, provision being made to extend the building as required. The building is almost entirely covered with corrugated actinic glass, providing the best possible light. The floors are of creosoted wood blocks on a concrete base. Ample traveling hoist facilities are provided.

GENERAL DIE-CASTING Co., Reading, Pa., incorporated a few months ago, has recently completed a steel construction fireproof factory for the production of die-cast parts on a plot of land of approximately three acres in the northwest section of Reading, adjoining the Pennsylvania and Reading railroads. This building is the first of three units which will give the plant, when completed, an ultimate floor space of between 200,000 and 300,000 square feet. The plant is under the management of F. C. Morrison, vice-president and general manager, who for more than twelve years was manager of the die-casting division of the Light Mfg. & Foundry Co., Pottstown, Pa.

* * *

THE RAILROAD SITUATION

Freight loadings continue at a high level, and traffic reports and forecasts are highly favorable, both as to the efficiency of the roads and the prospect of continued large movements of commodities. The number of engines and freight cars on hand in good condition and available for service is unusually large. As a result, the demand for new cars and locomotives is light, and it is not likely that the manufacturers of such equipment will receive any large orders from the railroads for some time to come. In spite of the heavier traffic, it is being handled so well, and the equipment is so well maintained, that the surplus of rolling stock reaches unusually high figures.

CAN YOU BEAT THIS?

Talking about return on your Investment

On the average when one Cincinnati Centerless Grinder is installed, it replaces four machines and four operators. Production is increased 50 to 300%.

And the great news about this machine is that new fields, new uses and new applications for the Cincinnati Centerless Grinder are being found daily. Steel, iron, glass, fibre, wood, raw-hide, rubber and reed are among the materials now ground.

Do not say that your job cannot be put on the Centerless Grinder. Write to us and find out what the Cincinnati Centerless Grinder will do.

PATENT NOTICE

In addition to our own patents, we are licensed under all the basic centerless grinding patents, including the Heim reissue patent 15035, recently sustained by the decision of the U. S. Circuit Court of Appeals. In the purchase of our machines, therefore, our customers are protected against infringement of centerless grinding patents.

THE CINCINNATI MILLING MACHINE CO.,
CINCINNATI, OHIO

Investigate Centerless Grinding, the new method of grinding.

1. **Form grinding**
2. **Straight cylindrical work**
3. **Two-diameter work**
4. **Shoulder grinding**
5. **Quick change over from one job to another**
6. **Great variety of wheel speeds providing absolute flexibility.**
7. **Spindles and housings mounted in rigid frames.**
8. **Easy to apply attachments.**

CINCINNATI CENTERLESS GRINDERS

COMING EVENTS

SEPTEMBER 8-11—Machine Tool Exhibition in the Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn. H. R. Westcott, chairman, 400 Temple St., New Haven, Conn.

SEPTEMBER 14-18—Annual convention of the American Society for Steel Treating, and Seventh National Steel Exposition, to be held at the Public Auditorium, Cleveland, Ohio. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

SEPTEMBER 14-19—Radio Fair to be held at the 258th Field Artillery Armory, New York City. For further information write Calvin Harris, Hotel San Remo, New York City.

SEPTEMBER 15-16—Production meeting of the Society of Automotive Engineers at Cleveland, Ohio. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

SEPTEMBER 28–OCTOBER 3—Tenth exposition of chemical industries at Grand Central Palace, New York City.

OCTOBER 5-9—Annual convention of the American Foundrymen's Association at Syracuse, N. Y. An exhibition of foundry and machine shop equipment and supplies will be held in connection with the convention.

NOVEMBER 30—DECEMBER 5—Fourth national exposition of power and mechanical engineering to be held in the Grand Central Palace, New York City.

SOCIETIES, SCHOOLS AND COLLEGES

UNIVERSITY OF DELAWARE, Newark, Del. Annual catalogue for 1924-1925, containing outline of courses, calendar for 1925-1926, etc.

NEW BOOKS AND PAMPHLETS

STANDARD SPECIFICATIONS AND METHODS OF TEST FOR MATERIALS. By C. L. Warwick. 19 pages, 6¾ by 9¾ inches. Published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa.

THE INVESTIGATION OF ANTENNAE BY MEANS OF MODELS. By J. Tykocinski-Tykociner. 60 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 147 of the Engineering Experiment Station. Price, 35 cents.

A STUDY OF THE SEASONAL VARIATION OF RADIO-FREQUENCY PHASE DIFFERENCE OF LAMINATED PHENOLIC INSULATING MATERIALS. By J. L. Preston and E. L. Hall. 10 pages, 7 by 10 inches. Published by the United States Department of Commerce, Washington, D. C., as Technologic Paper No. 284 of the Bureau of Standards.

RELEASE OF INTERNAL STRESS IN BRASS TUBING. By Robert J. Anderson and Everett G. Fahlman. 32 pages, 7 by 10 inches. Published by the Department of Commerce as Technologic Paper of the Bureau of Standards No. 285. Obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 15 cents.

SUPERHEAT ENGINEERING DATA. 208 pages, 4½ by 7 inches; 85 illustrations. Published by the Superheater Co., 17 E. 42nd St., New York City. Price, $1.

This is the sixth revised edition of a handbook on the generation and use of superheated steam and related subjects. In the preparation of this book, the aim has been to condense for ready reference the data most frequently required by steam power plant engineers and operators.

AUTOMOBILE TROUBLE CHART. By Victor W. Page. 25 by 38 inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York. Price, 35 cents.

This chart shows all parts of a typical six-cylinder automobile engine of the four-cycle type, and contains a list of the common derangements that interfere with the operation of motors of this type. It describes clearly the part affected, nature of trouble, symptoms and effects, and remedies.

NEW CATALOGUES AND CIRCULARS

DISK GRINDER. Badger Tool Co., Beloit, Wis. Circular illustrating and describing the Badger construction of disk grinders.

WINDING ENGINES. Warner Elevator Mfg. Co., Cincinnati, Ohio. Bulletin F-18, descriptive of the Warner type F-18 dumbwaiter winding engine.

SWITCHBOARDS. General Electric Co., Schenectady, N. Y. Booklet 87,000-E, covering the installation, operation, and maintenance of switchboards.

ELECTRIC JUNCTION CONDULETS. Crouse-Hinds Co., Syracuse, N. Y. Folder illustrating and describing the screw-cover junction condulets and connection blocks made by the company.

BALL BEARINGS. New Departure Mfg. Co., Bristol, Conn. Leaflet 166-FE, for loose-leaf binder, descriptive of the application of New Departure ball bearings in an automatic oil burner.

SHOP DRINKING FOUNTAINS. Century Brass Works, Inc., 351 N. Illinois St., Belleville, Ill. Circular illustrating and describing drinking fountains for machine shops and industrial establishments.

SAFETY SET-SCREWS. Bristol Co., Waterbury, Conn. Folder illustrating and describing the "Bristo" safety set-screws, with dovetailed flutes. A table of sizes and price list of safety set-screws is included.

WATERPROOFING AND DAMPPROOFING. Truscon Laboratories, Detroit, Mich. Book "A", containing specifications in regard to waterproofing, dampproofing, and oilproofing masonry and concrete surfaces.

WIRE. Bridgeport Brass Co., Bridgeport, Conn. Booklet on phono-electric contact wire for electrical installations, giving the reason for the use of wire of this kind, and containing other information relating to its properties.

PULLEYS. T. B. Wood's Sons Co., Chambersburg, Pa. Bulletin 368, illustrating, describing, and giving tables of dimensions and list prices of U. G. cast-iron motor pulleys, machine-molded, and carefully balanced at motor speeds.

MOTORS. Master Electric Co., Linden and Master Aves., Dayton, Ohio. Form 308, entitled "Master Quality with Service," illustrating the construction of Master motors and describing the characteristics of the different types.

ELECTRIC MOTORS. Wagner Electric Corporation, St. Louis, Mo. Booklet entitled "Fifty Questions and Answers about Power Factor," explaining what the power factor is, and the importance, cost, and control of magnetizing current.

BOLT AND NUT MACHINES. National Machinery Co., Tiffin, Ohio. Folder announcing the second exposition of advanced methods and designs in forging machines and bolt and nut machinery to be held at the company's plant August 24 to 26.

COUNTERBORES. Gairing Tool Co., Inc., 19 W. Woodbridge Ave., Detroit, Mich. Circular illustrating and describing the Gairing interchangeable counterbores, spot-facing tools, countersinks, core drills with interchangeable tips, and offset spot-facing head.

FLEXIBLE COUPLINGS. T. B. Wood's Sons Co., Chambersburg, Pa. Bulletin 168, illustrating, describing, and giving dimensions and list prices of the universal "Giant" flexible couplings built by the company. The circular describes four different types.

DIE SETS FOR STAMPINGS. Danly Machine Specialties, Inc., 4907 Lincoln Ave., Chicago, Ill. Twelve-page circular illustrating and describing in detail the procedure in the manufacture of die sets by interchangeable manufacturing methods in the company's plant.

STAINLESS STEEL AND IRON. American Stainless Steel Co., Commonwealth Bldg., Pittsburgh, Pa. Circular entitled "Meeting a Nation's Need," outlining briefly the points of interest of stainless irons and steels to the consumer, jobber and dealer, and manufacturer.

PULLEY GRINDER. Graham Mfg. Co., Providence, R. I. Circular F, illustrating and describing the Graham pulley grinding machine for finishing the face or belt surface of metal pulleys from the rough, after chucking the holes. The faces may be ground straight, round, or hollow.

SHEARS. Long & Allstatter Co., Hamilton, Ohio. Folder illustrating and describing the gate or squaring shears made by this company, which are intended for quick and accurate squaring, cross-cutting, and splitting of plates and sheets. Capacities and other data covering the various sizes are given in tabular form.

TURRET LATHES. Warner & Swasey Co., Cleveland, Ohio. Circular entitled "Where to Look for Net Profits," containing concise information on methods suitable to production in small lots, average lots, and quantity, and showing savings that have been made possible by the use of machines built by the company.

PYROMETERS. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Catalogue 87, on "Potentiometer Pyrometers," containing complete information on the subject of pyrometers, and illustrating and describing, in addition, the different types made by the company. A treatise on the theory of the potentiometer pyrometer concludes the catalogue.

THREADING MACHINES. Landis Machine Co., Waynesboro, Pa. Booklet entitled "Thread with Landis," containing illustrations showing Landis threading machines in use on different classes of work in railroad shops, oil fields, and other shops where thread-cutting operations are required. The different styles of machines as well as die-heads and taps are also illustrated.

CRILLY MERCURY BEARING METAL. Metal Sales Co., 511 Bergen Ave., Jersey City, N. J., is distributing a card giving the size and weight of stock sizes of Crilly mercury bearing metal. The card also gives examples showing how the approximate weight of any size of solid or cored bar of bronze or mercury metal can be determined.

GRINDING WHEEL STANDS. Norton Co., Worcester, Mass. Catalogue of grinding wheel stands, protection hoods and accessories, referring to the characteristic features of the machines built by the company, and illustrating and describing different types. Complete specifications are included. Also circular illustrating and describing 16-, 20-, and 24-inch type S grinding wheel stands.

FOUNDATIONS. Cork Foundation Co., 315 Fifth Ave., New York City. Circular describing "Absorbo," a material made from natural cork in strips set in rigid steel frames with lateral braces wherever required, and impregnated with creosote to render it impervious to oil and water so that it will not disintegrate. This material is used to absorb vibration in machinery foundations. The illustrations in the circular show drop and helve hammers, air compressors, fans and motors, and other machinery mounted on foundation pads of this material.

MILLING MACHINES. Kempsmith Mfg. Co., Milwaukee, Wis. Catalogue C of Kempsmith knee-type, cone-pulley drive, and production-type milling machines, illustrating and describing, in all, twenty-one different milling machines built by the company, together with milling attachments of different types for use with these machines. Also circulars illustrating and describing separately, the company's plain, universal, and vertical "Maximillers"; vertical-spindle, circular, and universal milling attachments; slotting attachment; and rack-cutting attachment.

MACHINERY'S DATA SHEETS Nos. 41 and 42

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

APPROXIMATE DIMENSIONS OF DRAWN SHELLS

Diam. of Flat Blank	Percentage of Reduction in First Drawing Die*											
	20		25		30		35		40		45	
	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height
1	0.80	0.11	0.75	0.15	0.70	0.18	0.65	0.22	0.60	0.27	0.55	0.32
1¼	1.00	0.14	0.94	0.18	0.88	0.23	0.81	0.28	0.75	0.33	0.69	0.40
1½	1.20	0.17	1.12	0.22	1.05	0.27	0.98	0.33	0.90	0.40	0.83	0.48
1¾	1.40	0.20	1.31	0.25	1.23	0.32	1.14	0.39	1.05	0.47	0.96	0.55
2	1.60	0.22	1.50	0.29	1.40	0.36	1.30	0.44	1.20	0.53	1.10	0.63
2¼	1.80	0.25	1.69	0.33	1.58	0.41	1.46	0.50	1.35	0.60	1.24	0.71
2½	2.00	0.28	1.87	0.36	1.75	0.46	1.63	0.56	1.50	0.67	1.38	0.79
2¾	2.20	0.31	2.06	0.40	1.93	0.50	1.79	0.61	1.65	0.73	1.51	0.87
3	2.40	0.34	2.25	0.44	2.10	0.55	1.95	0.67	1.80	0.80	1.65	0.95
3¼	2.60	0.37	2.44	0.47	2.28	0.59	2.11	0.72	1.95	0.87	1.79	1.03
3½	2.80	0.39	2.62	0.51	2.45	0.64	2.28	0.78	2.10	0.93	1.93	1.11
3¾	3.00	0.42	2.81	0.55	2.63	0.68	2.44	0.83	2.25	1.00	2.06	1.19
4	3.20	0.45	3.00	0.58	2.80	0.73	2.60	0.89	2.40	1.07	2.20	1.27
4¼	3.40	0.48	3.19	0.62	2.98	0.77	2.76	0.95	2.55	1.13	2.34	1.35
4½	3.60	0.51	3.38	0.66	3.15	0.82	2.93	1.00	2.70	1.20	2.48	1.43
4¾	3.80	0.53	3.56	0.69	3.33	0.86	3.09	1.05	2.85	1.27	2.61	1.51
5	4.00	0.56	3.75	0.73	3.50	0.91	3.25	1.11	3.00	1.33	2.75	1.59
5¼	4.20	0.59	3.94	0.77	3.68	0.96	3.41	1.17	3.15	1.40	2.89	1.66
5½	4.40	0.62	4.12	0.80	3.85	1.00	3.58	1.22	3.30	1.47	3.03	1.74
5¾	4.60	0.65	4.31	0.84	4.03	1.05	3.74	1.28	3.45	1.53	3.16	1.82
6	4.80	0.67	4.50	0.87	4.20	1.09	3.90	1.33	3.60	1.60	3.30	1.90
6¼	5.00	0.70	4.69	0.91	4.38	1.14	4.06	1.39	3.75	1.67	3.44	1.98
6½	5.20	0.73	4.87	0.95	4.55	1.18	4.23	1.44	3.90	1.73	3.58	2.06
6¾	5.40	0.76	5.06	0.98	4.73	1.23	4.39	1.50	4.05	1.80	3.71	2.14

*Steel, copper, brass, and aluminum shells can generally be reduced from 40 to 45 per cent in the first draw. Zinc shells can be reduced about 35 per cent. Owing to variations in the physical properties of the metal to be drawn, the allowable percentages of reduction may sometimes be greater or less than the percentages just mentioned, which apply to average conditions.

The figures in the table are based on the formula

$$D = \sqrt{d^2 + 4dh}$$

where D = blank diameter, d = shell diameter, and h = height of shell.

CUT HERE

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

APPROXIMATE DIMENSIONS OF DRAWN SHELLS

Diam. of Flat Blank	Percentage of Reduction in First Drawing Die*											
	20		25		30		35		40		45	
	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height
7	5.60	0.79	5.25	1.02	4.90	1.28	4.55	1.55	4.20	1.87	3.85	2.22
7¼	5.80	0.82	5.44	1.05	5.08	1.32	4.71	1.61	4.35	1.93	3.99	2.30
7½	6.00	0.84	5.62	1.09	5.25	1.37	4.88	1.67	4.50	2.00	4.13	2.38
7¾	6.20	0.87	5.81	1.13	5.43	1.41	5.04	1.72	4.65	2.07	4.26	2.46
8	6.40	0.90	6.00	1.16	5.60	1.46	5.20	1.78	4.80	2.14	4.40	2.54
8¼	6.60	0.93	6.19	1.20	5.78	1.51	5.36	1.83	4.95	2.20	4.54	2.62
8½	6.80	0.95	6.37	1.24	5.95	1.55	5.53	1.89	5.10	2.27	4.68	2.69
8¾	7.00	0.98	6.56	1.28	6.13	1.60	5.69	1.94	5.25	2.34	4.81	2.77
9	7.20	1.01	6.75	1.31	6.30	1.64	5.85	2.00	5.40	2.40	4.95	2.85
9¼	7.40	1.04	6.94	1.35	6.48	1.69	6.01	2.06	5.55	2.47	5.09	2.93
9½	7.60	1.07	7.12	1.38	6.65	1.73	6.18	2.11	5.70	2.53	5.23	3.01
9¾	7.80	1.10	7.31	1.42	6.83	1.78	6.34	2.17	5.85	2.60	5.36	3.09
10	8.00	1.12	7.50	1.46	7.00	1.82	6.50	2.22	6.00	2.67	5.50	3.17
10¼	8.20	1.15	7.69	1.49	7.18	1.87	6.66	2.28	6.15	2.73	5.64	3.25
10½	8.40	1.18	7.88	1.53	7.35	1.91	6.82	2.33	6.30	2.80	5.78	3.33
10¾	8.60	1.21	8.06	1.57	7.53	1.96	6.99	2.39	6.45	2.87	5.91	3.41
11	8.80	1.24	8.25	1.60	7.70	2.00	7.15	2.44	6.60	2.94	6.05	3.49
11¼	9.00	1.26	8.44	1.64	7.88	2.05	7.31	2.50	6.75	3.00	6.19	3.57
11½	9.20	1.29	8.63	1.68	8.05	2.09	7.47	2.56	6.90	3.07	6.33	3.65
11¾	9.40	1.32	8.82	1.71	8.23	2.14	7.64	2.61	7.05	3.13	6.46	3.73
12	9.60	1.35	9.00	1.75	8.40	2.19	7.80	2.67	7.20	3.20	6.60	3.80
12¼	9.80	1.38	9.19	1.79	8.58	2.23	7.96	2.72	7.35	3.27	6.74	3.88
12½	10.00	1.40	9.38	1.82	8.75	2.28	8.12	2.78	7.50	3.34	6.88	3.96
12¾	10.20	1.43	9.56	1.86	8.93	2.32	8.29	2.84	7.65	3.40	7.01	4.04

*Steel, copper, brass, and aluminum shells can generally be reduced from 40 to 45 per cent in the first draw. Zinc shells can be reduced about 35 per cent. Owing to variations in the physical properties of the metal to be drawn, the allowable percentages of reduction may sometimes be greater or less than the percentages just mentioned, which apply to average conditions.

The figures in the table are based on the formula

$$D = \sqrt{d^2 + 4dh}$$

where D = blank diameter, d = shell diameter, and h = height of shell.

MACHINERY'S DATA SHEETS Nos. 43 and 44

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

APPROXIMATE DIMENSIONS OF DRAWN SHELLS

Diam. of Flat Blank	Percentage of Reduction in First Drawing Die*											
	20		25		30		35		40		45	
	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height
13	10.40	1.46	9.75	1.89	9.10	2.37	8.45	2.89	7.80	3.47	7.15	4.12
13¼	10.60	1.49	9.94	1.93	9.28	2.42	8.61	2.95	7.95	3.53	7.29	4.20
13½	10.80	1.52	10.13	1.97	9.45	2.46	8.77	3.00	8.10	3.60	7.43	4.28
13¾	11.00	1.55	10.31	2.01	9.63	2.51	8.94	3.06	8.25	3.67	7.56	4.36
14	11.20	1.57	10.50	2.04	9.80	2.55	9.10	3.11	8.40	3.74	7.70	4.44
14¼	11.40	1.60	10.69	2.08	9.98	2.60	9.26	3.17	8.55	3.80	7.84	4.52
14½	11.60	1.63	10.88	2.12	10.15	2.64	9.42	3.22	8.70	3.87	7.98	4.60
14¾	11.80	1.66	11.06	2.15	10.33	2.69	9.59	3.28	8.85	3.93	8.11	4.68
15	12.00	1.68	11.25	2.19	10.50	2.73	9.75	3.34	9.00	4.00	8.25	4.76
15¼	12.20	1.71	11.43	2.22	10.68	2.78	9.91	3.39	9.15	4.07	8.39	4.83
15½	12.40	1.74	11.62	2.26	10.85	2.82	10.07	3.44	9.30	4.13	8.53	4.91
15¾	12.60	1.77	11.81	2.30	11.03	2.87	10.24	3.50	9.45	4.20	8.66	4.99
16	12.80	1.80	12.00	2.33	11.20	2.92	10.40	3.56	9.60	4.27	8.80	5.07
16¼	13.00	1.83	12.19	2.37	11.38	2.96	10.56	3.61	9.75	4.34	8.94	5.15
16½	13.20	1.86	12.38	2.41	11.55	3.01	10.72	3.67	9.90	4.40	9.08	5.23
16¾	13.40	1.88	12.57	2.44	11.73	3.06	10.89	3.72	10.05	4.47	9.21	5.31
17	13.60	1.91	12.75	2.48	11.90	3.10	11.05	3.78	10.20	4.53	9.35	5.39
17¼	13.80	1.94	12.93	2.52	12.08	3.14	11.21	3.84	10.35	4.60	9.49	5.47
17½	14.00	1.97	13.12	2.55	12.25	3.19	11.37	3.89	10.50	4.67	9.63	5.55
17¾	14.20	2.00	13.31	2.59	12.43	3.24	11.54	3.95	10.65	4.74	9.76	5.63
18	14.40	2.02	13.50	2.62	12.60	3.28	11.70	4.00	10.80	4.80	9.90	5.71
18¼	14.60	2.05	13.68	2.66	12.78	3.33	11.86	4.06	10.95	4.87	10.04	5.79
18½	14.80	2.08	13.87	2.70	12.95	3.37	12.02	4.12	11.10	4.94	10.18	5.87
18¾	15.00	2.11	14.06	2.73	13.13	3.42	12.19	4.17	11.25	5.00	10.31	5.94

*Steel, copper, brass, and aluminum shells can generally be reduced from 40 to 45 per cent in the first draw. Zinc shells can be reduced about 35 per cent. Owing to variations in the physical properties of the metal to be drawn, the allowable percentages of reduction may sometimes be greater or less than the percentages just mentioned, which apply to average conditions.

The figures in the table are based on the formula

$$D = \sqrt{d^2 + 4dh}$$

where D = blank diameter, d = shell diameter, and h = height of shell.

MACHINERY'S Data Sheet No. 43, New Series, October 1924

CUT HERE

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

APPROXIMATE DIMENSIONS OF DRAWN SHELLS

Diam. of Flat Blank	Percentage of Reduction in First Drawing Die*											
	20		25		30		35		40		45	
	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height	Shell Diam.	Shell Height
19	15.20	2.14	14.24	2.77	13.30	3.46	12.35	4.23	11.40	5.07	10.45	6.02
19¼	15.40	2.16	14.43	2.81	13.48	3.51	12.51	4.28	11.55	5.14	10.59	6.10
19½	15.60	2.19	14.62	2.84	13.65	3.55	12.67	4.34	11.70	5.20	10.73	6.18
19¾	15.80	2.22	14.81	2.88	13.83	3.50	12.84	4.39	11.85	5.27	10.86	6.26
20	16.00	2.25	15.00	2.92	14.00	3.64	13.00	4.44	12.00	5.33	11.00	6.34
20¼	16.20	2.28	15.19	2.96	14.18	3.69	13.16	4.50	12.15	5.40	11.14	6.42
20½	16.40	2.31	15.38	2.99	14.35	3.74	13.32	4.56	12.30	5.47	11.28	6.50
20¾	16.60	2.34	15.56	3.03	14.53	3.78	13.49	4.61	12.45	5.54	11.41	6.58
21	16.80	2.36	15.75	3.06	14.70	3.83	13.65	4.67	12.60	5.60	11.55	6.66
21¼	17.00	2.39	15.94	3.10	14.88	3.88	13.81	4.73	12.75	5.67	11.69	6.74
21½	17.20	2.42	16.12	3.14	15.05	3.92	13.97	4.78	12.90	5.73	11.83	6.82
21¾	17.40	2.45	16.31	3.18	15.23	3.96	14.14	4.83	13.05	5.80	11.96	6.90
22	17.60	2.48	16.50	3.21	15.40	4.01	14.30	4.89	13.20	5.87	12.10	6.97
22¼	17.80	2.50	16.69	3.24	15.58	4.05	14.46	4.95	13.35	5.93	12.24	7.05
22½	18.00	2.53	16.88	3.28	15.75	4.10	14.62	5.00	13.50	6.00	12.38	7.13
22¾	18.20	2.56	17.06	3.32	15.93	4.14	14.79	5.06	13.65	6.07	12.51	7.21
23	18.40	2.59	17.25	3.35	16.10	4.19	14.95	5.11	13.80	6.13	12.65	7.29
23¼	18.60	2.62	17.43	3.39	16.28	4.23	15.11	5.17	13.95	6.20	12.79	7.37
23½	18.80	2.64	17.62	3.42	16.45	4.28	15.27	5.23	14.10	6.27	12.93	7.45
23¾	19.00	2.67	17.81	3.46	16.63	4.32	15.44	5.28	14.25	6.34	13.06	7.53
24	19.20	2.70	18.00	3.50	16.80	4.37	15.60	5.33	14.40	6.40	13.20	7.61

*Steel, copper, brass, and aluminum shells can generally be reduced from 40 to 45 per cent in the first draw. Zinc shells can be reduced about 35 per cent. Owing to variations in the physical properties of the metal to be drawn, the allowable percentages of reduction may sometimes be greater or less than the percentages just mentioned, which apply to average conditions.

The figures in the table are based on the formula

$$D = \sqrt{d^2 + 4dh}$$

where D = blank diameter, d = shell diameter, and h = height of shell.

MACHINERY'S Data Sheet No. 44, New Series, October 1924

MACHINERY'S DATA SHEETS Nos. 45 and 46

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

STANDARD TOOTH PROPORTIONS

Adopted as Recommended Practice by the American Gear Manufacturers' Association

Dimension, Inches	Full-depth Tooth		Stub Tooth (See Notes 1, 2, 3, and 4)	
	Based on Diametral Pitch	Based on Circular Pitch	Based on Diametral Pitch	Based on Circular Bitch
Addendum	$\frac{1}{D.P.}$	0.3183 × C.P.	$\frac{0.8}{D.P.}$	0.2546 × C.P.
Dedendum (Minimum)	$\frac{1.157}{D.P.}$	0.3683 × C.P.	$\frac{1}{D.P.}$	0.3183 × C.P.
Working Depth	$\frac{2}{D.P.}$	0.6366 × C.P.	$\frac{1.6}{D.P.}$	0.5092 × C.P.
Total Depth (Minimum)	$\frac{2.157}{D.P.}$	0.6866 × C.P.	$\frac{1.8}{D.P.}$	0.5729 × C.P.
Pitch Diameter	$\frac{N}{D.P.}$	0.3183 × N × C.P.	$\frac{N}{D.P.}$	0.3183 × N × C.P.
Outside Diameter	$\frac{N+2}{D.P.}$	0.3183 × (N+2) × C.P.	$\frac{N+1.6}{D.P.}$	P.D. + (2 × A)
Basic Tooth Thickness on Pitch Line	$\frac{1.5708}{D.P.}$	0.5 × C.P.	$\frac{1.5708}{D.P.}$	0.5 × C.P.

NOTATION

D.P. = diametral pitch;
C.P. = circular pitch;
P.D. = pitch diameter;
N = number of teeth; and
A = addendum.

Note 1. The pressure angle adopted for the stub tooth is 20 degrees.

Note 2. The proportions adopted for stub teeth are identical with those of the recommended practice for herringbone gears.

Note 3. A minimum clearance of $\frac{0.2}{D.P.}$ is recommended for new cutters and gears. There is correct tooth action, however, between gears cut to this new system and those cut to the older Nuttall System, the only dimension affected being the clearance. Where the new standard gear runs with a Nuttall gear there is a clearance of $\frac{0.1425}{D.P.}$, and where a Nuttall gear runs with a standard gear the clearance is $\frac{0.2146}{D.P.}$.

Note 4. Use the diametral pitch in calculating the proportions of gears up to and including 1 D.P. and the circular pitch for larger teeth.

CUT HERE

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

THREAD DIMENSIONS AND TAP DRILL SIZES—1

BASIC THREAD DIMENSIONS AND TAP DRILL SIZES ADOPTED BY TAP AND DIE MANUFACTURERS

United States Thread

Nominal Size	Outside Diameter, Inches	Pitch Diameter, Inches	Root Diameter, Inches	Commercial Tap Drill to Produce Approx. 75 Per Cent Full Thread	Decimal Equivalent of Tap Drill
1/16–64	0.0625	0.0524	0.0422	3/64	0.0469
72	0.0625	0.0535	0.0445	3/64	0.0469
5/64–60	0.0781	0.0673	0.0563	1/16	0.0625
72	0.0781	0.0691	0.0601	52	0.0635
3/32–48	0.0938	0.0803	0.0667	49	0.0730
50	0.0938	0.0808	0.0678	49	0.0730
7/64–48	0.1094	0.0959	0.0823	43	0.0890
1/8–32	0.1250	0.1047	0.0844	3/32	0.0937
40	0.1250	0.1088	0.0925	38	0.1015
9/64–40	0.1406	0.1244	0.1081	32	0.1160
5/32–32	0.1563	0.1360	0.1157	1/8	0.1250
36	0.1563	0.1382	0.1202	30	0.1285
11/64–32	0.1719	0.1505	0.1313	9/64	0.1406
3/16–24	0.1875	0.1604	0.1334	26	0.1470
32	0.1875	0.1672	0.1469	22	0.1570
13/64–24	0.2031	0.1760	0.1490	20	0.1610
7/32–24	0.2188	0.1919	0.1646	16	0.1770
32	0.2188	0.1985	0.1782	12	0.1890
15/64–24	0.2344	0.2073	0.1806	10	0.1935
1/4–20	0.2500	0.2175	0.1850	7	0.2010
24	0.2500	0.2229	0.1959	4	0.2090
27	0.2500	0.2260	0.2019	3	0.2130
28	0.2500	0.2268	0.2036	3	0.2130
32	0.2500	0.2297	0.2094	7/32	0.2187
5/16–18	0.3125	0.2764	0.2403	F	0.2570
20	0.3125	0.2800	0.2476	17/64	0.2656
24	0.3125	0.2854	0.2584	I	0.2720
27	0.3125	0.2884	0.2644	J	0.2770
32	0.3125	0.2922	0.2719	9/32	0.2812

MACHINERY'S DATA SHEETS Nos. 47 and 48

PUNCH Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. PUNCH

THREAD DIMENSIONS AND TAP DRILL SIZES—2

BASIC THREAD DIMENSIONS AND TAP DRILL SIZES ADOPTED BY TAP AND DIE MANUFACTURERS

United States Thread

Nominal Size	Outside Diameter, Inches	Pitch Diameter, Inches	Root Diameter, Inches	Commercial Tap Drill to Produce Approx. 75 Per Cent Full Thread	Decimal Equivalent of Tap Drill
3/8–16	0.3750	0.3344	0.2938	5/16	0.3125
20	0.3750	0.3425	0.3100	21/64	0.3281
24	0.3750	0.3479	0.3209	Q	0.3320
27	0.3750	0.3509	0.3269	R	0.3390
7/16–14	0.4375	0.3911	0.3447	U	0.3680
20	0.4375	0.4050	0.3726	25/64	0.3906
24	0.4375	0.4104	0.3834	X	0.3970
27	0.4375	0.4134	0.3894	Y	0.4040
1/2–12	0.5000	0.4459	0.3918	27/64	0.4219
13	0.5000	0.4501	0.4001	27/64	0.4219
20	0.5000	0.4675	0.4351	29/64	0.4531
24	0.5000	0.4729	0.4459	29/64	0.4531
27	0.5000	0.4759	0.4519	15/32	0.4687
9/16–12	0.5625	0.5084	0.4542	31/64	0.4844
18	0.5625	0.5264	0.4903	33/64	0.5156
27	0.5625	0.5384	0.5144	17/32	0.5312
5/8–11	0.6250	0.5660	0.5069	17/32	0.5312
12	0.6250	0.5709	0.5168	35/64	0.5469
18	0.6250	0.5889	0.5528	37/64	0.5781
27	0.6250	0.6009	0.5769	19/32	0.5937
11/16–11	0.6875	0.6285	0.5694	19/32	0.5937
16	0.6875	0.6469	0.6063	5/8	0.6250
3/4–10	0.7500	0.6850	0.6201	21/32	0.6562
12	0.7500	0.6959	0.6418	43/64	0.6719
16	0.7500	0.7094	0.6688	11/16	0.6875
27	0.7500	0.7259	0.7019	23/32	0.7187
13/16–10	0.8125	0.7476	0.6826	23/32	0.7187
7/8–9	0.8750	0.8029	0.7307	49/64	0.7656
12	0.8750	0.8209	0.7668	51/64	0.7969
14	0.8750	0.8286	0.7822	13/16	0.8125
18	0.8750	0.8389	0.8028	53/64	0.8281
27	0.8750	0.8509	0.8269	27/32	0.8437

CUT HERE

PUNCH Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. PUNCH

THREAD DIMENSIONS AND TAP DRILL SIZES—3

BASIC THREAD DIMENSIONS AND TAP DRILL SIZES ADOPTED BY TAP AND DIE MANUFACTURERS

United States Thread

Nominal Size	Outside Diameter, Inches	Pitch Diameter, Inches	Root Diameter, Inches	Commercial Tap Drill to Produce Approx. 75 Per Cent Full Thread	Decimal Equivalent of Tap Drill
15/16–9	0.9375	0.8654	0.7932	53/64	0.8281
1–8	1.0000	0.9188	0.8376	7/8	0.8750
12	1.0000	0.9459	0.8918	59/64	0.9219
14	1.0000	0.9536	0.9072	15/16	0.9375
27	1.0000	0.9759	0.9519	31/32	0.9687
1 1/8–7	1.1250	1.0322	0.9394	63/64	0.9844
12	1.1250	1.0709	1.0168	1 3/64	1.0469
1 1/4–7	1.2500	1.1572	1.0644	1 7/64	1.1094
12	1.2500	1.1959	1.1418	1 11/64	1.1719
1 3/8–6	1.3750	1.2668	1.1585	1 7/32	1.2187
12	1.3750	1.3209	1.2668	1 19/64	1.2969
1 1/2–6	1.5000	1.3917	1.2835	1 11/32	1.3437
12	1.5000	1.4459	1.3918	1 27/64	1.4219
1 5/8–5 1/2	1.6250	1.5070	1.3888	1 29/64	1.4531
1 3/4–5	1.7500	1.6201	1.4902	1 9/16	1.5625
1 7/8–5	1.8750	1.7451	1.6152	1 11/16	1.6875
2–4 1/2	2.0000	1.8557	1.7113	1 25/32	1.7812
2 1/8–4 1/2	2.1250	1.9807	1.8363	1 29/32	1.9062
2 1/4–4 1/2	2.2500	2.1057	1.9613	2 1/32	2.0312
2 3/8–4	2.3750	2.2126	2.0502	2 1/8	2.1250
2 1/2–4	2.5000	2.3376	2.1752	2 1/4	2.2500
2 3/4–4	2.7500	2.5876	2.4252	2 1/2	2.5000
3–3 1/2	3.0000	2.8145	2.6288	2 23/32	2.7187
3 1/4–3 1/2	3.2500	3.0645	2.8788	2 31/32	2.9687
3 1/2–3 1/4	3.5000	3.3002	3.1003	3 3/16	3.1875
3 3/4–3	3.7500	3.5335	3.3170	3 7/16	3.4375
4–3	4.0000	3.7835	3.5670	3 11/16	3.6875

MACHINERY'S DATA SHEETS Nos. 49 and 50

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

TOLERANCES FOR HAND TAPS

COMMERCIAL TOLERANCES FOR HAND TAPS, PULLEY TAPS AND TAPS FOR BEAMAN & SMITH HOLDERS, AS ADOPTED BY THE TAP AND DIE MANUFACTURERS

United States Standard Thread

Size	Basic		Tap Measurements					
			Outside Diameter			Pitch Diameter		
	Outside Diam.	Pitch Diam.	Minimum	Maximum	Tolerance	Minimum	Maximum	Tolerance
1/4–20	0.2500	0.2175	0.2510	0.2535	0.0025	0.2180	0.2200	0.0020
5/16–18	0.3125	0.2764	0.3135	0.3160	0.0025	0.2769	0.2789	0.0020
3/8–16	0.3750	0.3344	0.3760	0.3785	0.0025	0.3349	0.3369	0.0020
7/16–14	0.4375	0.3911	0.4385	0.4415	0.0030	0.3916	0.3941	0.0025
1/2–13	0.5000	0.4500	0.5010	0.5040	0.0030	0.4505	0.4530	0.0025
9/16–12	0.5625	0.5084	0.5635	0.5665	0.0030	0.5089	0.5114	0.0025
5/8–11	0.6250	0.5660	0.6260	0.6290	0.0030	0.5665	0.5690	0.0025
3/4–10	0.7500	0.6850	0.7510	0.7550	0.0040	0.6855	0.6885	0.0030
7/8–9	0.8750	0.8028	0.8760	0.8800	0.0040	0.8033	0.8063	0.0030
1–8	1.0000	0.9188	1.0010	1.0050	0.0040	0.9193	0.9223	0.0030
1 1/8–7	1.1250	1.0322	1.1265	1.1310	0.0045	1.0327	1.0362	0.0035
1 1/4–7	1.2500	1.1572	1.2515	1.2560	0.0045	1.1577	1.1612	0.0035
1 3/8–6	1.3750	1.2668	1.3765	1.3810	0.0045	1.2673	1.2708	0.0035
1 1/2–6	1.5000	1.3917	1.5015	1.5060	0.0045	1.3922	1.3957	0.0035
1 5/8–5 1/2	1.6250	1.5069	1.6265	1.6320	0.0055	1.5079	1.5119	0.0040
1 3/4–5	1.7500	1.6201	1.7515	1.7570	0.0055	1.6211	1.6251	0.0040
1 7/8–5	1.8750	1.7451	1.8765	1.8820	0.0055	1.7461	1.7501	0.0040
2–4 1/2	2.0000	1.8557	2.0015	2.0070	0.0055	1.8567	1.8607	0.0040
2 1/8–4 1/2	2.1250	1.9807	2.1270	2.1330	0.0060	1.9817	1.9862	0.0045
2 1/4–4 1/2	2.2500	2.1057	2.2520	2.2580	0.0060	2.1067	2.1112	0.0045
2 3/8–4	2.3750	2.2126	2.3770	2.3830	0.0060	2.2136	2.2181	0.0045
2 1/2–4	2.5000	2.3376	2.5020	2.5080	0.0060	2.3386	2.3431	0.0045
2 5/8–4	2.6250	2.4626	2.6270	2.6340	0.0070	2.4636	2.4686	0.0050
2 3/4–4	2.7500	2.5876	2.7520	2.7590	0.0070	2.5886	2.5936	0.0050
2 7/8–3 1/2	2.8750	2.6894	2.8770	2.8840	0.0070	2.6904	2.6954	0.0050
3–3 1/2	3.0000	2.8144	3.0020	3.0090	0.0070	2.8154	2.8204	0.0050

LEAD TOLERANCE

A maximum lead error of plus or minus 0.003 inch in one inch of thread is permitted.

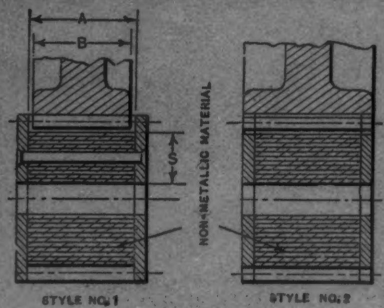
MACHINERY'S Data Sheet No. 49, New Series, January 1925

CUT HERE

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

STANDARD RAWHIDE GEARING

American Gear Manufacturers' Association



Pinions made with hubs (bushings or spiders) or with steel or cast-iron flanges are special construction. For strength and economical service, pinions should be made with not less than 15 teeth. To avoid charring rawhide by excessive speeds, the maximum pitch velocity should not exceed 2500 feet per minute.

Number of Teeth	Number of Rivets: 1 to 4 Pitch	5 to 6 Pitch	8 to 12 Pitch	Number of Teeth	Number of Rivets: 1 to 4 Pitch	5 to 6 Pitch	8 to 12 Pitch
12	5	5	4	27	6	6	6
13	5	5	4	28	7	6	6
14	5	5	4	29	7	6	6
15	5	5	5	30	7	6	6
16	5	5	5	31	7	6	6
17	5	5	5	32	7	6	6
18	5	5	5	33	7	6	6
19	5	5	5	34	7	6	6
20	6	5	5	35	7	6	6
21	6	5	5	36	8	7	7
22	6	6	6	37	8	7	7
23	6	6	6	38	8	7	7
24	6	6	6	39	8	7	7
25	6	6	6	40	8	7	7
26	6	6	6				

Diametral Pitch	Minimum Dimension for S	Thickness of Brass Retainers					Diameter of Rivets		Difference between Face Widths of Metal and Composition Gears Style No. 1 (A-B)
		Style No. 1		Style No. 2					
		12 to 20 Teeth	21 Teeth and Over	12 to 16 Teeth	17 to 25 Teeth	26 Teeth and Over	12 to 23 Teeth	24 Teeth and Over	
1	3	7/8	1	7/8	1	1 1/8	5/8	3/4	5/8
1 1/4	2 3/8	11/16	13/16	11/16	13/16	7/8	1/2	5/8	1/2
1 1/2	2	19/32	21/32	19/32	21/32	3/4	7/16	9/16	7/16
1 3/4	1 11/16	1/2	9/16	1/2	9/16	5/8	3/8	1/2	3/8
2	1 1/2	7/16	1/2	7/16	1/2	9/16	3/8	7/16	5/16
2 1/2	1 3/16	11/32	13/32	11/32	13/32	15/32	5/16	3/8	1/4
3	1	9/32	11/32	9/32	11/32	3/8	1/4	5/16	1/4
4	3/4	7/32	9/32	7/32	9/32	5/16	3/16	1/4	3/16
5	5/8	3/16	7/32	3/16	7/32	9/32	3/16	1/4	3/16
6	5/8	5/32	7/32	5/32	7/32	1/4	3/16	1/4	3/16
7	1/2	5/32	3/16	5/32	3/16	1/4	3/16	3/16	3/16
8	1/2	5/32	3/16	5/32	3/16	7/32	1/8	3/16	3/16
10	3/8	1/8	5/32	1/8	5/32	3/16	1/8	3/16	3/16
12	3/8	1/8	5/32	1/8	5/32	3/16	1/8	3/16	3/16

MACHINERY'S Data Sheet No. 50, New Series, January 1925

Adopted October 14, 1919, and revised September 12, 1923.

MACHINERY'S DATA SHEETS Nos. 51 and 52

CUT OUT ON THIS LINE

PUNCH

Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally.

PUNCH

TAPS WITH GROUND THREADS

COMMERCIAL TOLERANCES FOR GROUND THREAD TAPS AS ADOPTED BY THE TAP AND DIE MANUFACTURERS

United States Standard

Size	Basic		Tap Measurements					
			Outside Diameter			Pitch Diameter		
	Outside Diam.	Pitch Diam.	Mini-mum	Maxi-mum	Toler-ance	Mini-mum	Maxi-mum	Toler-ance
1/4–20	0.2500	0.2175	0.2520	0.2535	0.0015	0.2180	0.2190	0.0010
5/16–18	0.3125	0.2764	0.3145	0.3160	0.0015	0.2769	0.2779	0.0010
3/8–16	0.3750	0.3344	0.3770	0.3785	0.0015	0.3349	0.3359	0.0010
7/16–14	0.4375	0.3911	0.4400	0.4415	0.0015	0.3916	0.3926	0.0010
1/2–13	0.5000	0.4500	0.5025	0.5040	0.0015	0.4505	0.4515	0.0010
9/16–12	0.5625	0.5084	0.5650	0.5665	0.0015	0.5089	0.5099	0.0010
5/8–11	0.6250	0.5660	0.6275	0.6290	0.0015	0.5665	0.5675	0.0010
3/4–10	0.7500	0.6850	0.7530	0.7550	0.0020	0.6855	0.6865	0.0010
7/8–9	0.8750	0.8028	0.8780	0.8800	0.0020	0.8033	0.8043	0.0010
1–8	1.0000	0.9188	1.0030	1.0050	0.0020	0.9193	0.9203	0.0010
1 1/8–7	1.1250	1.0322	1.1290	1.1310	0.0020	1.0327	1.0342	0.0015
1 1/4–7	1.2500	1.1572	1.2540	1.2560	0.0020	1.1577	1.1592	0.0015
1 3/8–6	1.3750	1.2668	1.3790	1.3810	0.0020	1.2673	1.2688	0.0015
1 1/2–6	1.5000	1.3917	1.5040	1.5060	0.0020	1.3922	1.3937	0.0015
1 3/4–5	1.7500	1.6201	1.7550	1.7570	0.0020	1.6206	1.6221	0.0015
2–4 1/2	2.0000	1.8557	2.0050	2.0070	0.0020	1.8562	1.8577	0.0015
2 1/4–4 1/2	2.2500	2.1057	2.2560	2.2580	0.0020	2.1062	2.1082	0.0020
2 1/2–4	2.5000	2.3376	2.5060	2.5080	0.0020	2.3381	2.3401	0.0020
2 3/4–4	2.7500	2.5876	2.7570	2.7590	0.0020	2.5881	2.5901	0.0020
3–3 1/2	3.0000	2.8144	3.0070	3.0090	0.0020	2.8149	2.8169	0.0020

LEAD TOLERANCE

A maximum lead error of plus or minus 0.0005 inch in one inch of thread is permitted.

MARKING

Taps will be marked with the diameter, number of threads per inch and standard. A symbol indicating ground thread is also recommended, for example:

A tap one inch diameter with eight threads per inch will be marked:

1"–8 U. S. S.
G

CUT HERE

PUNCH

Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally.

PUNCH

TAPS WITH GROUND THREADS

COMMERCIAL TOLERANCES FOR GROUND THREAD TAPS AS ADOPTED BY THE TAP AND DIE MANUFACTURERS

S. A. E. Standard

Size	Basic		Tap Measurements					
			Outside Diameter			Pitch Diameter		
	Outside Diam.	Pitch Diam.	Mini-mum	Maxi-mum	Toler-ance	Mini-mum	Maxi-mum	Toler-ance
1/4–28	0.2500	0.2268	0.2520	0.2535	0.0015	0.2273	0.2283	0.0010
5/16–24	0.3125	0.2854	0.3145	0.3160	0.0015	0.2859	0.2869	0.0010
3/8–24	0.3750	0.3479	0.3770	0.3785	0.0015	0.3484	0.3494	0.0010
7/16–20	0.4375	0.4050	0.4395	0.4410	0.0015	0.4055	0.4065	0.0010
1/2–20	0.5000	0.4675	0.5020	0.5035	0.0015	0.4680	0.4690	0.0010
9/16–18	0.5625	0.5264	0.5645	0.5660	0.0015	0.5269	0.5279	0.0010
5/8–18	0.6250	0.5889	0.6270	0.6285	0.0015	0.5894	0.5904	0.0010
11/16–16	0.6875	0.6469	0.6895	0.6910	0.0015	0.6474	0.6484	0.0010
3/4–16	0.7500	0.7094	0.7520	0.7535	0.0015	0.7099	0.7109	0.0010
7/8–14	0.8750	0.8286	0.8775	0.8790	0.0015	0.8291	0.8301	0.0010
7/8–18	0.8750	0.8389	0.8770	0.8785	0.0015	0.8394	0.8404	0.0010
1–14	1.0000	0.9536	1.0025	1.0040	0.0015	0.9541	0.9551	0.0010
1 1/8–12	1.1250	1.0709	1.1275	1.1290	0.0015	1.0714	1.0729	0.0015
1 1/4–12	1.2500	1.1959	1.2525	1.2540	0.0015	1.1964	1.1979	0.0015
1 3/8–12	1.3750	1.3209	1.3775	1.3790	0.0015	1.3214	1.3229	0.0015
1 1/2–12	1.5000	1.4459	1.5025	1.5040	0.0015	1.4464	1.4479	0.0015

LEAD TOLERANCE

A maximum lead error of plus or minus 0.0005 inch in one inch of thread is permitted.

MARKING

Taps will be marked with the diameter, number of threads per inch and standard. A symbol indicating ground thread is also recommended, for example:

A tap one inch diameter with fourteen threads per inch will be marked:

1"–14 S. A. E. Std.
G

CUT OUT ON THIS LINE

MACHINERY'S DATA SHEETS Nos. 53 and 54

CUT OUT ON THIS LINE

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

HELICAL ROUND-BAR STEEL SPRINGS

TABLES FOR CALCULATING HELICAL ROUND-BAR STEEL SPRINGS

By JOSEPH H. SULLIVAN, Springfield, Ohio

Data Sheet No. 54, and the Data Sheets to follow in April, May, and June, apply to helical round-bar steel springs. They are calculated for a fiber stress of 100,000 pounds per square inch, with a modulus of elasticity of 11,520,000, and apply to high-grade spring wire. The standard steel wire gage is used, which is the same as the American Steel & Wire Co.'s, the Washburn & Moen, and the Roebling gage.

To obtain the values in the tables, the sizes from No. 26 to No. 4 steel wire gage are blued at 600 degrees F., permitted to cool, and then compressed solid, when they should return to the calculated free height. To obtain the values for springs from No. 3½ steel wire gage to ⅝ inch diameter, the heat-treatment to which these springs are subjected is as follows: Heat the spring to a red heat and dip it into oil, keeping it in the oil until it is quite cool; then burn off or flash off the oil, which has the same effect as drawing the temper. An exception is made in the case of car springs, which are dipped into oil and taken out again while they still show red or dark red. These springs are not flashed off.

Wire springs from No. 26 to No. 4 steel wire gage are allowed to remain some time in the oil (usually from 5 to 7 minutes); they are then thrown on the floor and the temper is drawn during the last hours of the day when the heat of the furnace is going down, or during the first hour in the morning when the heat is coming up.

The basis of 100,000 pounds per square inch stress, which has been used for calculating the tables, is an ample figure for use for steel wire gage sizes from No. 26 to No. 4, but may be considered the limiting value for sizes from No. 3½ to ⅝ inch diameter.

The Data Sheets give in the extreme left-hand columns the size of the wire from which the spring is made, both by gage number (steel wire gage) and in decimals. Along the top of the tables is given the mean or pitch diameter of the spring. To find the values relating to any one spring, therefore, first locate in the left-hand column the size of the wire from which the spring is made and then follow the horizontal line from this size to the column headed by the mean diameter of the spring. For example, assume that the values for a spring made from No. 20 wire gage having a mean or pitch diameter of ⅜ inch are to be found. In Data Sheet No. 54 we find three values given one above the other corresponding to this size of spring, as follows: 4.49, 0.109, and 40. The top value gives the load in pounds required to compress the spring solid, or the total capacity of the spring. In this case 4.49 pounds would be required to compress the spring solid. The second value 0.109 gives the movement per coil in inches when the spring is compressed from its free height to solid, this value also often being known as the "deflection under total load, per coil." In this case the deflection under a load of 4.49 pounds is 0.109 inch per coil. The third value 40 is a "load compression value"; if this value is divided by the number of working coils in the entire spring, the load in pounds required to compress the spring one inch will be found.

The spring tables may be applied to stresses other than 100,000 pounds per square inch by taking a percentage of the load as shown in the tables corresponding to the percentage that the stress required is of 100,000 pounds; for example, if we wish to design springs in which the fiber stress is only 60,000 pounds per square inch, the load and the movement per coil are only 60 per cent of the values found in the table. The third value, the load-compression value, remains the same no matter what the fiber stress is.

MACHINERY'S Data Sheet No. 53, New Series, March 1925

CUT HERE

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

HELICAL ROUND-BAR STEEL SPRINGS

Size of Wire, Steel Wire Gage	Diam. of Wire, Inches	Mean or Pitch Diameter of Spring, Inches											
		1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	3/8	7/16	1/2
26	0.0181	3.72	2.48	1.86	1.49	1.24	1.06	0.940	0.827	.....	.....	.....	.....
		0.0059	0.0133	0.0236	0.037	0.053	0.072	0.094	0.119	.....	.....	.....	.....
		630	186	79	40	23	15	10	7	.....	.....	.....	.....
25	0.020	5.03	3.35	2.51	2.00	1.67	1.43	1.25	1.11	1.00	0.837	.....	.....
		0.0053	0.0119	0.0213	0.0328	0.0478	0.0652	0.0852	0.107	0.131	0.191	.....	.....
		947	280	118	88	35	21	14	10	7.6	4.3	.....	.....
24	0.023	7.64	5.10	3.82	3.06	2.55	2.19	1.91	1.70	1.52	1.27	.....	.....
		0.0046	0.0104	0.0184	0.0285	0.0406	0.0571	0.0714	0.0937	0.114	0.162	.....	.....
		1600	500	200	100	62	38	25	18	13	8	.....	.....
23	0.025	9.82	6.54	4.90	3.92	3.27	2.70	2.45	2.18	1.96	1.63	1.35	.....
		0.0042	0.0095	0.0170	0.026	0.038	0.052	0.068	0.086	0.105	0.152	0.209	.....
		2300	680	280	150	85	50	36	25	18	10	6	.....
22	0.028	......	9.19	6.89	5.51	4.59	3.94	3.45	3.06	2.75	2.30	1.97	.....
		......	0.0085	0.0152	0.023	0.034	0.046	0.060	0.077	0.093	0.137	0.186	.....
		......	1070	450	235	135	84	56	40	29	16.6	10.5	.....
1/32"	0.031	......	12.76	9.57	7.65	6.38	5.47	4.78	4.25	3.83	3.19	2.73	.....
		......	0.0076	0.0136	0.021	0.030	0.041	0.054	0.069	0.084	0.103	0.166	.....
		......	1650	700	360	200	130	85	60	45	30	16	.....
20	0.035	......	......	13.47	10.77	8.98	7.69	6.73	5.98	5.38	4.49	3.84	3.36
		......	......	0.012	0.019	0.027	0.037	0.048	0.061	0.075	0.109	0.149	0.193
		......	......	1100	560	330	200	138	97	70	40	25	17
19	0.041	......	......	......	......	14.43	12.37	10.82	9.62	8.62	7.21	6.18	5.41
		......	......	......	......	0.023	0.032	0.041	0.052	0.064	0.093	0.127	0.166
		......	......	......	......	600	380	260	180	130	77	45	32

MACHINERY'S Data Sheet No. 54, New Series, March 1925

Contributed by Joseph H. Sullivan

MACHINERY'S DATA SHEETS Nos. 55 and 56

HELICAL ROUND-BAR STEEL SPRINGS

Size of Wire, Steel Wire Gage	Diameter of Wire, Inches	Mean or Pitch Diameter of Spring, Inches																
		3/16	7/32	1/4	9/32	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	1	1 1/8
18	0.0475	22.44 0.020 1120	19.21 0.028 680	16.83 0.036 465	14.96 0.045 330	13.46 0.056 240	11.22 0.080 140	9.61 0.110 87	8.41 0.144 58	7.48 0.182 40	6.73 0.224 30	6.12 0.273 22	5.61 0.323 17	For complete directions, see Data Sheet No. 53, March, 1925				
17	0.054	....	28.26 0.024 1180	24.73 0.031 800	21.98 0.040 500	19.80 0.049 400	16.50 0.071 230	14.13 0.096 145	12.36 0.126 95	10.99 0.158 68	9.90 0.194 50	9.00 0.238 38	8.25 0.284 29	....	....	....	....	....
16	0.0625	....	....	38.35 0.027 1400	34.09 0.034 1000	30.67 0.042 720	25.56 0.061 410	21.91 0.083 260	19.17 0.108 170	17.04 0.138 120	15.34 0.168 90	13.91 0.206 65	12.78 0.245 52	11.80 0.288 40	10.95 0.334 30	10.22 0.383 25	9.58 0.485 21	8.52 0.552 15
15	0.072	....	....	58.23 0.0236 2460	51.72 0.031 1630	46.58 0.037 1250	38.80 0.053 730	33.27 0.069 480	29.11 0.095 300	25.86 0.119 215	23.29 0.148 155	21.17 0.178 118	19.40 0.213 90	18.05 0.250 77	16.63 0.276 60	15.63 0.333 47	14.55 0.378 38	12.93 0.479 26
14	0.080	....	....	80.42 0.0213 3700	71.48 0.027 2640	64.34 0.033 1940	53.6 0.048 1110	46.0 0.065 700	40.2 0.085 470	35.7 0.107 330	32.17 0.133 240	29.2 0.162 180	26.8 0.191 140	24.7 0.225 110	23.0 0.261 88	21.4 0.300 70	20.1 0.341 59	17.8 0.431 40
13½	0.08575	....	....	99 0.020 4950	88 0.025 3500	79 0.031 2550	66 0.046 1440	56.5 0.061 926	49.5 0.079 623	44.0 0.100 440	39.6 0.124 319	36.0 0.150 240	33.0 0.179 185	30.4 0.210 145	28.3 0.244 116	26.4 0.281 94	24.7 0.318 78	22.0 0.402 55
13	0.091	....	....	120 0.0185 6400	107 0.023 4600	92 0.029 3300	80 0.042 1900	69 0.057 1200	60 0.074 800	53.4 0.094 560	48.1 0.116 400	43.7 0.141 300	40.1 0.167 240	37.0 0.197 185	34.3 0.228 150	32.0 0.263 120	30.0 0.297 100	26.7 0.377 70
12½	0.0985	....	....	150 0.017 8600	133 0.022 6000	120 0.027 4400	100 0.039 2550	85.8 0.053 1600	75.0 0.069 1080	66.7 0.087 760	60.0 0.108 555	54.6 0.131 400	50.0 0.155 320	46.0 0.182 250	42.9 0.212 200	40.0 0.243 164	37.5 0.276 135	33.3 0.350 95

Contributed by Joseph H. Sullivan

CUT HERE

HELICAL ROUND-BAR STEEL SPRINGS

Size of Wire, Steel Wire Gage	Diam. of Wire, Inches	Mean or Pitch Diameter of Spring, Inches																			
		5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 1/4
12	0.1055	145 0.025 5770	121 0.036 3300	104 0.049 2050	91 0.065 1400	81 0.082 980	73 0.101 720	66 0.122 540	61 0.146 410	52 0.198 260	45 0.260 170	40 0.328 120	36 0.406 89	33 0.488 67	30 0.584 50	28 0.686 40	26 0.795 32	24 0.913 26	22.7 1.038 20	For complete directions, see Data Sheet No. 53, March, 1925	
11½	0.113	181 0.023 7700	151 0.034 4400	129 0.046 2800	113 0.060 1850	100 0.076 1300	91 0.094 960	82 0.113 780	75 0.136 550	64.7 0.185 340	56.6 0.241 234	50.3 0.305 165	45.3 0.377 120	41.1 0.454 90	37.8 0.543 69	34.8 0.637 54	32.3 0.739 43	30.1 0.848 35	28.3 0.964 29		
11	0.120	... ...	180 0.032 5600	155 0.043 3600	136 0.057 2380	121 0.072 1670	108 0.089 1200	99 0.106 930	90.4 0.128 700	77.5 0.174 445	67.8 0.227 300	60.3 0.287 260	54.2 0.355 150	49.3 0.427 115	45.2 0.511 88	41.7 0.600 70	38.7 0.696 55	36.2 0.800 45	33.9 0.909 37	31.9 1.026 31	30.1 1.150 27
10½	0.127	... ...	214 0.029 7300	183 0.041 4400	161 0.053 3000	143 0.068 2000	128 0.084 1500	117 0.101 1100	107 0.121 880	92 0.164 550	80 0.214 370	71.5 0.271 260	64 0.335 190	58.5 0.404 140	53.6 0.483 110	49 0.567 85	46 0.657 70	42.9 0.755 56	40 0.858 46	38 0.970 39	36 1.084 33
10	0.135	... ...	... ...	220 0.039 5500	193 0.050 3800	172 0.064 2680	155 0.079 1960	140 0.095 1460	129 0.113 1140	110 0.154 700	96 0.202 470	86 0.255 330	77 0.315 240	70 0.380 180	64 0.454 140	59.4 0.533 110	55 0.618 88	51.5 0.710 72	48 0.808 59	45.4 0.912 49	43 1.070 42
9½	0.141	... ...	... ...	252 0.037 6700	220 0.048 4500	196 0.061 3100	176 0.075 2300	160 0.091 1700	147 0.109 1300	126 0.148 840	110 0.193 550	98 0.244 400	89 0.302 290	80 0.364 200	73 0.435 165	68 0.510 130	63 0.594 105	59 0.680 85	55 0.772 70	51.8 0.873 59	49 0.978 50
9	0.148	... ...	... ...	... ...	254 0.046 5500	224 0.058 3860	203 0.072 2800	185 0.087 2100	170 0.103 1650	146 0.141 1000	127 0.184 690	112 0.233 480	102 0.287 355	93 0.350 265	85 0.412 206	78.3 0.486 160	73 0.564 129	68 0.648 104	63.6 0.736 86	60 0.832 72	56 0.932 60
8½	0.1562	... ...	... ...	... ...	299 0.043 7000	266 0.055 4800	239 0.068 3500	218 0.082 2650	199 0.098 2000	171 0.134 1270	149 0.174 855	133 0.220 600	120 0.272 440	109 0.330 330	100 0.392 260	92 0.460 200	85.5 0.534 160	79.5 0.611 130	74.5 0.696 107	70.5 0.788 90	66.5 0.883 75

Contributed by Joseph H. Sullivan

MACHINERY'S DATA SHEETS Nos. 57 and 58

PUNCH

Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally.

PUNCH

HELICAL ROUND-BAR STEEL SPRINGS

Size of Wire, Steel Wire Gage	Diameter of Wire, Inches	Mean or Pitch Diameter of Spring, Inches																		
		9/16	5/8	11/16	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 1/4	2 3/8	2 1/2	2 5/8
8	0.162	296	267	243	223	191	167	148	133	121	111	102	95	89	83	78.5	74	70.3	66.7	63.6
		0.053	0.066	0.080	0.095	0.129	0.162	0.213	0.263	0.320	0.378	0.444	0.515	0.591	0.673	0.760	0.851	0.949	1.052	1.165
		5380	4000	3000	2300	1480	1000	700	500	380	295	230	184	150	123	103	86	74	63	54
7½	0.170	343	309	280	257	220	193	171	154	140	128	119	110	103	96	91	85.7	81	77	73.5
		0.051	0.063	0.076	0.090	0.123	0.160	0.203	0.261	0.302	0.361	0.423	0.491	0.563	0.641	0.724	0.812	0.905	1.043	1.108
		6700	4900	3680	2800	1780	1200	840	590	460	350	280	240	180	148	125	105	90	74	65
7	0.177	387	348	316	290	249	217	193	174	158	145	134	124	116	109	102	97	92	87	83
		0.049	0.060	0.073	0.087	0.118	0.154	0.195	0.240	0.289	0.346	0.407	0.472	0.541	0.616	0.696	0.780	0.870	0.962	1.064
		7900	5800	4300	3300	2100	1400	1000	725	540	418	329	262	214	175	146	124	105	90	78
3/16"	0.1875	....	414	376	345	296	259	230	207	188	172	159	148	139	129	122	115	109	103	98.6
		....	0.057	0.069	0.081	0.111	0.145	0.184	0.227	0.276	0.327	0.384	0.445	0.511	0.582	0.657	0.736	0.800	0.908	1.004
		....	7250	5440	4250	2650	1730	1250	900	680	520	410	330	270	220	170	156	135	110	98
6	0.192	....	445	404	370	317	278	247	222	202	184	171	159	148	139	131	123	117	111	106
		....	0.055	0.067	0.080	0.108	0.142	0.180	0.222	0.267	0.320	0.375	0.435	0.499	0.568	0.641	0.720	0.801	0.887	0.981
		....	8000	6000	4600	2900	1900	1370	1000	750	570	450	365	296	244	200	170	145	125	108
5	0.207	....	....	506	464	398	348	309	278	253	232	214	199	186	174	164	154	147	139	132
		....	....	0.062	0.074	0.100	0.131	0.166	0.206	0.248	0.296	0.347	0.403	0.462	0.526	0.595	0.666	0.743	0.824	0.910
		....	....	8000	6200	3900	2600	1850	1350	1000	780	610	490	400	330	275	230	200	168	145
7/32"	0.21875	....	....	....	553	473	414	368	331	301	276	255	237	221	207	195	184	174	165	158
		....	....	....	0.070	0.095	0.125	0.158	0.195	0.234	0.280	0.329	0.381	0.438	0.498	0.563	0.631	0.703	0.779	0.861
		....	....	....	7900	4960	3330	2325	1700	1280	985	775	620	500	415	345	290	245	210	183
4	0.2253	For complete directions, see Data Sheet No. 58, March, 1925			596	512	447	397	357	325	298	275	256	238	223	210	199	188	178	170
					0.068	0.093	0.121	0.153	0.189	0.228	0.272	0.320	0.371	0.426	0.484	0.547	0.613	0.683	0.757	0.837
					8700	5500	3690	2580	1850	1400	1090	850	660	550	460	380	324	275	235	200

MACHINERY'S Data Sheet No. 57, New Series, May 1925 Contributed by Joseph H. Sullivan

CUT HERE

PUNCH

Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally.

PUNCH

HELICAL ROUND-BAR STEEL SPRINGS

Size of Wire, Steel Wire Gage	Diameter of Wire, Inches	Mean or Pitch Diameter of Spring, Inches																			
		1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 1/4	2 3/8	2 1/2	2 5/8	2 3/4	2 7/8	3	3 1/4	3 1/2	3 3/4	4
3½	0.234	447	402	366	335	310	287	269	251	237	223	212	201	191	183	175	168	155	144	134	126
		0.147	0.182	0.220	0.262	0.308	0.357	0.410	0.467	0.526	0.590	0.657	0.728	0.805	0.881	0.963	1.048	1.232	1.428	1.640	1.869
		3000	2200	1650	1270	1000	800	650	530	440	375	320	275	235	207	180	160	125	100	80	67
3	0.244	507	456	414	380	351	326	304	285	268	253	240	228	217	207	199	190	175	163	152	142
		0.141	0.175	0.210	0.250	0.295	0.342	0.392	0.447	0.504	0.565	0.630	0.698	0.771	0.840	0.923	1.000	1.180	1.368	1.568	1.788
		3590	2600	1970	1500	1185	950	775	637	530	447	380	326	280	246	215	190	148	119	97	79
¼"	0.250	545	491	446	409	378	351	327	307	289	273	258	245	233	223	213	204	189	175	164	153
		0.138	0.170	0.205	0.245	0.288	0.334	0.383	0.436	0.492	0.552	0.615	0.680	0.753	0.820	0.901	0.983	1.152	1.336	1.533	1.744
		3940	2880	2170	1665	1310	1050	850	700	587	494	419	360	310	270	236	205	164	130	106	87
2	0.263	635	571	519	476	440	408	381	357	336	317	301	285	272	259	249	238	220	204	190	178
		0.131	0.162	0.195	0.233	0.273	0.317	0.364	0.414	0.468	0.524	0.585	0.648	0.716	0.780	0.857	0.933	1.095	1.270	1.468	1.656
		4820	3520	2660	2000	1600	1280	1045	860	720	600	510	440	380	330	290	255	193	160	128	107
1	0.283	788	710	646	592	546	507	474	444	418	398	374	355	338	323	309	296	273	254	237	222
		0.122	0.150	0.181	0.217	0.254	0.295	0.339	0.386	0.435	0.487	0.543	0.602	0.665	0.724	0.797	0.868	1.017	1.180	1.355	1.545
		6450	4750	3565	2725	2140	1718	1400	1150	960	817	688	590	508	446	387	341	268	215	175	143
0	0.307	1005	909	826	757	699	649	606	568	535	505	478	454	433	413	395	378	350	324	303	284
		0.112	0.139	0.168	0.200	0.234	0.272	0.312	0.355	0.401	0.450	0.501	0.555	0.613	0.671	0.734	0.800	0.938	1.090	1.249	1.421
		9000	6500	4900	3780	2990	2380	1940	1600	1300	1120	950	810	700	615	540	470	370	300	240	200
5/16"	0.3125	1073	966	880	805	743	690	644	604	568	537	509	483	460	439	420	403	371	345	322	302
		0.110	0.136	0.165	0.196	0.230	0.267	0.307	0.349	0.394	0.441	0.492	0.545	0.608	0.660	0.721	0.785	0.922	1.069	1.227	1.396
		9700	7000	5300	4100	3200	2580	2100	1860	1440	1210	1000	885	780	665	580	510	400	320	260	215
00	0.331	1266	1146	1035	949	876	814	765	712	670	633	600	570	542	518	495	474	438	407	382	356
		0.104	0.129	0.136	0.185	0.218	0.252	0.289	0.329	0.372	0.416	0.465	0.515	0.569	0.623	0.681	0.741	0.870	1.009	1.158	1.316
		12,170	8880	6630	5130	4010	3230	2645	2165	1800	1520	1290	1100	952	830	726	638	500	403	329	270
11/32"	0.34375	....	1276	1160	1063	981	911	851	797	751	709	672	638	608	580	555	531	491	456	425	399
		....	0.124	0.149	0.178	0.209	0.243	0.279	0.314	0.358	0.401	0.447	0.495	0.548	0.597	0.656	0.712	0.837	0.971	1.116	1.259
		....	10,200	7785	6970	4690	3750	3048	2530	2097	1768	1500	1290	1100	970	846	760	586	469	380	317
000	0.362	....	1490	1355	1242	1146	1064	993	931	876	828	788	745	709	677	648	621	573	532	497	465
		....	0.116	0.140	0.168	0.196	0.231	0.265	0.301	0.337	0.377	0.421	0.467	0.520	0.562	0.620	0.678	0.784	0.923	1.059	1.204
		....	12,860	9670	7390	5845	4600	3745	3100	2600	2195	1870	1638	1363	1200	1040	916	730	576	468	385

MACHINERY'S Data Sheet No. 58, New Series, May 1925 Contributed by Joseph H. Sullivan

PUNCH
Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally.
PUNCH

MACHINERY'S DATA SHEETS Nos. 59 and 60

PUNCH

Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally.

PUNCH

HELICAL ROUND-BAR STEEL SPRINGS

Size of Wire, Steel Wire Gage	Diameter of Wire, Inches	Mean or Pitch Diameter of Spring, Inches																	
		1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 1/4	2 3/8	2 1/2	2 5/8	2 3/4	2 7/8	3	3 1/4	3 1/2	3 3/4	4	4 1/2
3/8"	0.375	1380 0.164 8400	1274 0.192 6600	1183 0.227 5200	1104 0.256 4300	1035 0.291 3550	974 0.328 2960	920 0.368 2500	872 0.410 2120	828 0.455 1810	789 0.504 1565	753 0.550 1365	720 0.601 1200	690 0.654 1050	637 0.768 829	591 0.891 660	553 1.022 540	518 1.164 445	460 1.572 225
13/32"	0.406	1752 0.151 11,600	1617 0.177 9130	1500 0.205 7300	1402 0.236 5900	1314 0.268 4900	1237 0.306 4040	1168 0.340 3430	1106 0.380 2900	1051 0.420 2600	1000 0.465 2150	955 0.508 1870	911 0.555 1640	876 0.604 1450	808 0.709 1130	750 0.822 912	701 0.944 740	657 1.074 610	584 1.360 425
7/16"	0.4375	2192 0.140 15,650	2022 0.165 12,250	1979 0.191 10,360	1754 0.219 8000	1644 0.249 6600	1547 0.281 5500	1460 0.315 4630	1384 0.351 3940	1315 0.389 3380	1252 0.430 2925	1192 0.471 2530	1144 0.515 2220	1096 0.560 1950	1011 0.658 1535	939 0.763 1230	877 0.876 1000	822 0.995 825	730 1.262 578
15/32"	0.46875	2696 0.130 20,500	2489 0.153 16,200	2311 0.178 13,000	2157 0.204 10,500	2022 0.232 8715	1903 0.263 7235	1797 0.295 6090	1703 0.328 5190	1617 0.363 4450	1541 0.401 3850	1470 0.440 3340	1407 0.480 2930	1348 0.523 2570	1244 0.614 2020	1155 0.713 1620	1078 0.818 1315	1011 0.931 1075	898 1.180 830
1/2"	0.500	3272 0.123 26,600	3021 0.144 21,000	2805 0.167 16,750	2617 0.192 13,600	2455 0.218 11,170	2310 0.246 9350	2181 0.276 7900	2066 0.308 6700	1967 0.341 5760	1870 0.376 4970	1785 0.413 4300	1707 0.450 3790	1636 0.491 3330	1510 0.576 2600	1402 0.668 2100	1309 0.767 1700	1227 0.873 1400	1091 1.104 975
17/32"	0.53125	3925 0.116 33,800	3623 0.135 26,800	3364 0.157 21,400	3141 0.180 17,400	2944 0.205 14,360	2770 0.232 11,940	2617 0.260 10,000	2475 0.289 8560	2355 0.320 7350	2242 0.354 6330	2144 0.388 5520	2048 0.424 4790	1962 0.462 4220	1811 0.542 3350	1682 0.628 2670	1575 0.721 2180	1472 0.820 1790	1308 1.040 1250
9/16"	0.5625	....	4301 0.128 33,600	3993 0.148 27,000	3727 0.170 21,900	3495 0.194 18,000	3289 0.219 15,000	3106 0.245 12,670	2943 0.273 10,770	2796 0.304 9190	2662 0.335 7940	2542 0.365 7000	2431 0.400 6000	2330 0.436 5340	2150 0.512 4170	1996 0.594 3360	1804 0.681 2730	1747 0.774 2240	1553 0.982 1580
19/32"	0.59375	....	....	4700 0.141 33,300	4383 0.161 27,200	4109 0.183 22,800	3867 0.207 19,100	3652 0.232 15,740	3460 0.259 13,300	3287 0.287 11,400	3131 0.317 9870	2988 0.347 8600	2858 0.380 7500	2739 0.413 6620	2529 0.485 5200	2348 0.562 4170	2196 0.645 3400	2054 0.734 2800	1826 0.934 1960
5/8"	0.625	For complete directions, see Data Sheet No. 58, March, 1925		....	5114 0.153 33,400	4793 0.175 27,300	4511 0.197 22,800	4261 0.220 19,300	4037 0.246 16,400	3835 0.272 14,000	3652 0.301 12,100	3486 0.330 10,550	3334 0.360 9200	3196 0.392 8150	2950 0.461 6350	2740 0.534 5130	2557 0.614 4160	2397 0.698 3400	2131 0.880 2420

Contributed by Joseph H. Sullivan

CUT HERE

PUNCH

Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally.

PUNCH

GRINDING LIMITS FOR CYLINDRICAL PARTS*

Diameter, Inches	Limits, Inches
Running Fits for Shafts—Speeds under 600 R.P.M. Ordinary Working Conditions	
Up to ½	— 0.0005 to — 0.001
½ to 1	— 0.00075 to — 0.0015
1 to 2	— 0.0015 to — 0.0025
2 to 3½	— 0.002 to — 0.003
3½ to 6	— 0.0025 to — 0.004
Running Fits for Shafts—Speeds over 600 R.P.M. Heavy Pressure—Working Conditions Severe	
Up to ½	— 0.0005 to — 0.001
½ to 1	— 0.001 to — 0.002
1 to 2	— 0.002 to — 0.003
2 to 3½	— 0.003 to — 0.004
3½ to 6	— 0.004 to — 0.005
Sliding Fits for Shafts with Gears, Clutches, or Similar Parts which must be Free to Slide	
Up to ½	— 0.0005 to — 0.001
½ to 1	— 0.00075 to — 0.0015
1 to 2	— 0.0015 to — 0.0025
2 to 3½	— 0.002 to — 0.003
3½ to 6	— 0.0025 to — 0.004
Standard Fits for Light Service where Part is Keyed to Shaft and Clamped Endwise—No Fitting	
Up to ½	Standard to — 0.00025
½ to 3½	Standard to — 0.0005
3½ to 6	Standard to — 0.00075
Standard Fits with Play Eliminated—Parts should Assemble Readily—Some Fitting and Selecting may be Required	
Up to ½	Standard to + 0.00025
½ to 3½	Standard to + 0.0005
3½ to 6	Standard to + 0.00075

Diameter, Inches	Limits, Inches
Driving Fits for Permanent Assembly of Parts so Located that Driving Cannot be Done Readily	
Up to ½	Standard to 0.00025
½ to 1	+ 0.00025 to + 0.0005
1 to 2	+ 0.0005 to + 0.00075
2 to 6	+ 0.0005 to + 0.001
Driving Fits for Permanent Assembly and Severe Duty and where there is Ample Room for Driving	
Up to 2	+ 0.0005 to + 0.001
2 to 3½	+ 0.00075 to + 0.00125
3½ to 6	+ 0.001 to + 0.0015
Forced Fits for Permanent Assembly and Very Severe Service—Hydraulic Press Used for Larger Parts	
Up to ½	+ 0.00075 to + 0.001
½ to 1	+ 0.001 to + 0.002
1 to 2	+ 0.002 to + 0.003
2 to 3½	+ 0.003 to + 0.004
3½ to 6	+ 0.004 to + 0.005
Shrinkage Fits—for Pieces to take Hardened Shells having a Thickness of ⅝ Inch or Less	
Up to 1	+ 0.00025 to + 0.0005
1 to 2	+ 0.0005 to + 0.00075
2 to 3½	+ 0.0005 to + 0.001
3½ to 6	+ 0.001 to + 0.0015
Shrinkage Fits—for Pieces to take Shells, etc., having a Thickness of More than ⅝ Inch	
Up to ½	+ 0.0005 to + 0.001
½ to 1	+ 0.001 to + 0.002
1 to 2	+ 0.002 to + 0.003
2 to 3½	+ 0.003 to + 0.004
3½ to 6	+ 0.004 to + 0.005

*Recommended by the Brown & Sharpe Mfg. Co. for use under ordinary conditions. The hole is considered standard and the limits given are based upon the standard hole. The grinding limits for holes in hardened pieces are: Up to 2 inches diameter inclusive, standard to 0.0005 inch large; to 3½ inches diameter inclusive, standard to 0.00075 inch large; to 6 inches diameter inclusive, standard to 0.001 inch large.

MACHINERY'S DATA SHEETS Nos. 61 and 62

PUNCH   Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally.   PUNCH

HORSEPOWER RATING TABLE FOR LEATHER BELTING 1

Based upon research by R. F. Jones under the auspices of the Leather Belting Exchange Foundation, Cornell University

Weight of Belt	Belt Speed, Feet per Minute							
	500	1000	1500	2000	2500	3000	3500	4000
	Horsepower per Inch of Width							
Light Single	0.75	1.45	2.16	2.87	3.53	4.15	4.70	5.20
Medium Single	0.90	1.80	2.68	3.55	4.35	5.15	5.80	6.42
Heavy Single	1.05	2.06	3.10	4.10	5.05	5.93	6.70	7.40
Light Double	1.25	2.53	3.76	4.95	6.10	7.17	8.12	9.00
Medium Double	1.52	3.08	4.60	6.00	7.40	8.70	9.90	10.95
Heavy Double	1.77	3.55	5.30	6.95	8.55	10.05	11.45	12.60
Medium Triple	2.05	4.10	6.10	8.05	9.88	11.60	13.15	14.50

Weight of Belt	Belt Speed, Feet per Minute							
	4500	5000	5500	6000	6500	7000	7500	8000
	Horsepower per Inch of Width							
Light Single	5.60	5.95	6.20	6.30	6.30	6.15	5.85	5.45
Medium Single	6.95	7.35	7.62	7.78	7.75	7.57	7.25	6.76
Heavy Single	8.00	8.42	8.75	8.92	8.92	8.75	8.36	7.76
Light Double	9.70	10.30	10.70	10.92	10.90	10.65	10.16	9.48
Medium Double	11.82	12.50	13.00	13.22	13.20	12.90	12.35	11.55
Heavy Double	13.60	14.35	14.92	15.22	15.20	14.85	14.20	13.20
Medium Triple	15.62	16.52	17.20	17.55	17.50	17.10	16.40	15.30

General Directions: (1) Determine the horsepower per inch of width from the table below. (2) Find the "correction factor" in Data Sheet No. 62 for given pulley diameter and center distance. (3) Multiply these values to obtain the correct horsepower per inch of belt width. (4) Divide the total horsepower to be transmitted, by the horsepower per inch of width, to obtain the required width of belt.

Note: In interpolating for speeds not given in the table, use the nearest 50 or 100 feet per minute. For example, if the actual belt speed is 1665 feet per minute, use 1650 feet per minute, or if the actual speed is 1690 feet per minute, use 1700 feet per minute. This table is intended only for drives that are horizontal or approximately horizontal.

Example—Find the horsepower rating per inch of width for medium single belt, assuming that the actual speed is 2860 feet per minute, the smaller pulley diameter 15 inches, the center distance 10 feet, and the position of the tight side of the belt below. (As the actual speed is 2860 feet per minute, use 2850 feet per minute as the given speed.)

1. Choose horsepower values for the nearest speeds, one higher and the other lower than the given speed. Thus, the horsepower at the lower table speed, or 2500 feet per minute, equals 4.35. The horsepower at the higher table speed of 3000 feet per minute equals 5.15.

2. Subtract the lower table speed from the given speed and divide by 500. Thus, 2850 — 2500 = 350 and 350 ÷ 500 = 0.7.

3. Subtract the horsepower at the lower table speed from the horsepower at the higher table speed. Thus, 5.15 — 4.35 = 0.8.

4. Multiply the results obtained by steps 2 and 3. Thus, 0.7 × 0.8 = 0.56.

5. Add the result of step No. 4 to the horsepower at the lower table speed. Thus, 4.35 + 0.56 = 4.91.

6. Multiply the correction factor found from Data Sheet No. 62 by the result obtained in step No. 5 to determine the correct horsepower per inch of belt width. The correction factor in this instance equals 0.82, and 4.91 × 0.82 = 4 horsepower.

CUT HERE

PUNCH   Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally.   PUNCH

HORSEPOWER RATING TABLE FOR LEATHER BELTING - 2

Based upon research by R. F. Jones under the auspices of the Leather Belting Exchange Foundation, Cornell University

Diameter of Smaller Pulley, Inches	Center Distance, in Feet, between Pulleys							
	4		6		8		10	
	Position of Tight Side of Belt and Correction Factors for Use with Data Sheet No. 61							
	Above	Below	Above	Below	Above	Below	Above	Below
4	0.53	0.53	0.54	0.55	0.55	0.57	0.56	0.59
5	0.59	0.59	0.60	0.62	0.62	0.64	0.63	0.66
6	0.62	0.62	0.63	0.65	0.65	0.68	0.66	0.70
8	0.66	0.66	0.67	0.69	0.69	0.72	0.70	0.74
10	0.68	0.68	0.70	0.71	0.71	0.74	0.73	0.77
12	0.70	0.70	0.72	0.74	0.73	0.77	0.75	0.79
15	0.73	0.73	0.74	0.76	0.76	0.79	0.77	0.82
18	0.75	0.75	0.76	0.78	0.78	0.81	0.79	0.84
24	0.77	0.77	0.79	0.81	0.81	0.84	0.82	0.87
30	0.79	0.79	0.81	0.82	0.82	0.86	0.84	0.89
36†	0.80	0.80	0.82	0.84	0.83	0.87	0.85	0.90

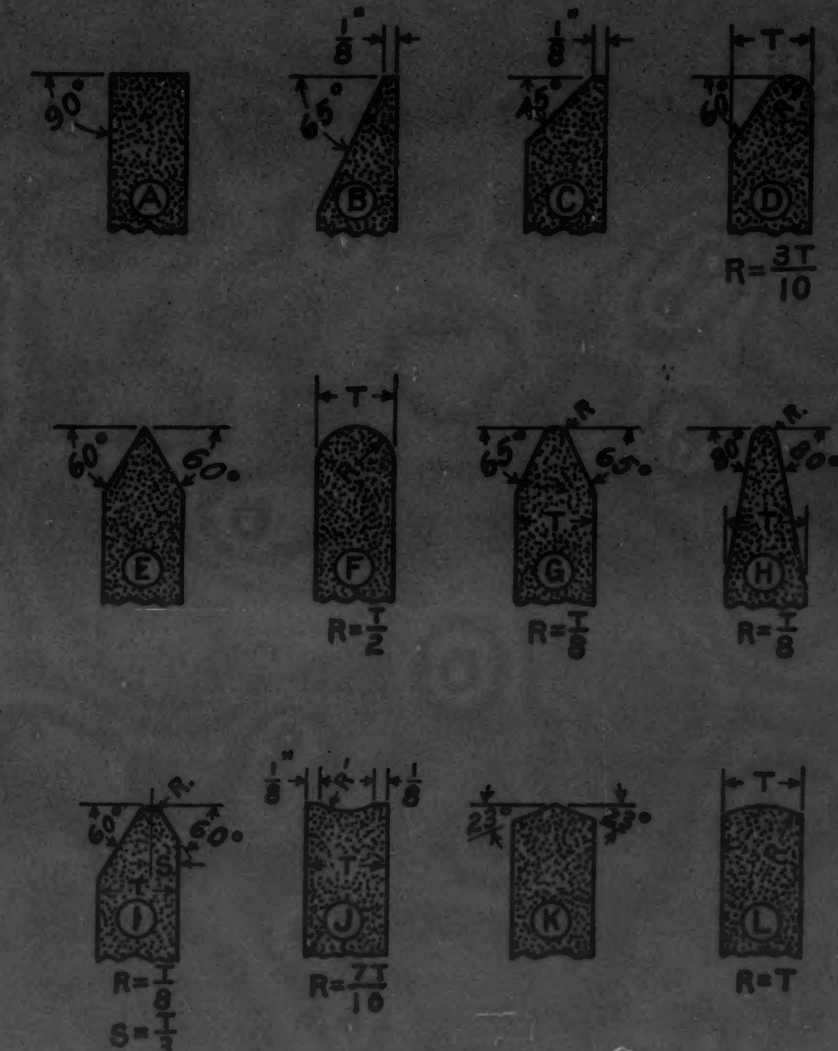
Diameter of Smaller Pulley, Inches	Center Distance, in Feet, between Pulleys							
	12		15		20		25*	
	Position of Tight Side of Belt and Correction Factors for Use with Data Sheet No. 61							
	Above	Below	Above	Below	Above	Below	Above	Below
4	0.57	0.61	0.58	0.63	0.59	0.65	0.59	0.66
5	0.63	0.68	0.65	0.70	0.66	0.72	0.66	0.74
6	0.67	0.72	0.68	0.74	0.69	0.76	0.70	0.78
8	0.71	0.76	0.73	0.78	0.73	0.80	0.74	0.82
10	0.73	0.79	0.75	0.81	0.76	0.83	0.77	0.85
12	0.76	0.81	0.77	0.83	0.78	0.86	0.79	0.88
15	0.78	0.84	0.80	0.86	0.81	0.89	0.82	0.91
18	0.80	0.86	0.82	0.89	0.83	0.91	0.84	0.93
24	0.83	0.89	0.85	0.92	0.86	0.94	0.87	0.96
30	0.85	0.91	0.87	0.94	0.88	0.96	0.89	0.98
36†	0.86	0.92	0.88	0.95	0.89	0.98	0.90	1.00

*If the center distance between pulleys is over 25 feet, use values given for 25 feet.
†If the smaller pulley is over 36 inches in diameter, use the values given for 36 inches.

MACHINERY'S DATA SHEETS Nos. 63 and 64

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

STANDARD SHAPES OF GRINDING WHEEL FACES*



*Approved by Grinding Wheel Manufacturers' Association of the United States and Canada.

MACHINERY'S Data Sheet No. 63, New Series, August, 1925

CUT HERE

PUNCH — Punch-holes are spaced to fit standard loose-leaf ring binders for sale by stationers generally. — PUNCH

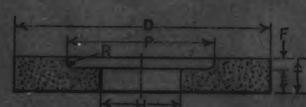
STANDARD GRINDING WHEELS*

Straight Wheels for Cylindrical Grinding

Type No. 1 — Straight

D	T	H
10	As ordered	5
12		5
14		5
16		5
18		5
18		8
20		5
20		8
20		12
24		5
24		8
24		12
26		12

Single-recess Wheels for Cylindrical Grinding



Type No. 5 — Recessed, One Side

D	T	H	P
10	As ordered	5	6 1/2
12		5	6 1/2
14		5	8
16		5	8
18		5	8 1/2
18		8	11
20		5	10 1/2
20		8	11
24		5	10 1/2
24		8	11

Double-recess Wheels for Cylindrical Grinding

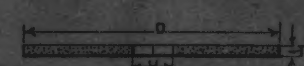
Type No. 7 — Recessed, Two Sides

D	T	H	P
14	As ordered	5	8
16		5	8
18		8	11
20		8	11
20		12	14 1/4
24		8	11
24		12	14 1/4
26		12	14 1/4

Depth of Recess for 8- and 12-inch Holes

T	F	G
With "T" less than 2″........	0	0
With "T" from 2″ up to 2 31/32″................	9/16	9/16
With "T" 3″ and larger........	13/16	13/16

Cutting-off Wheels

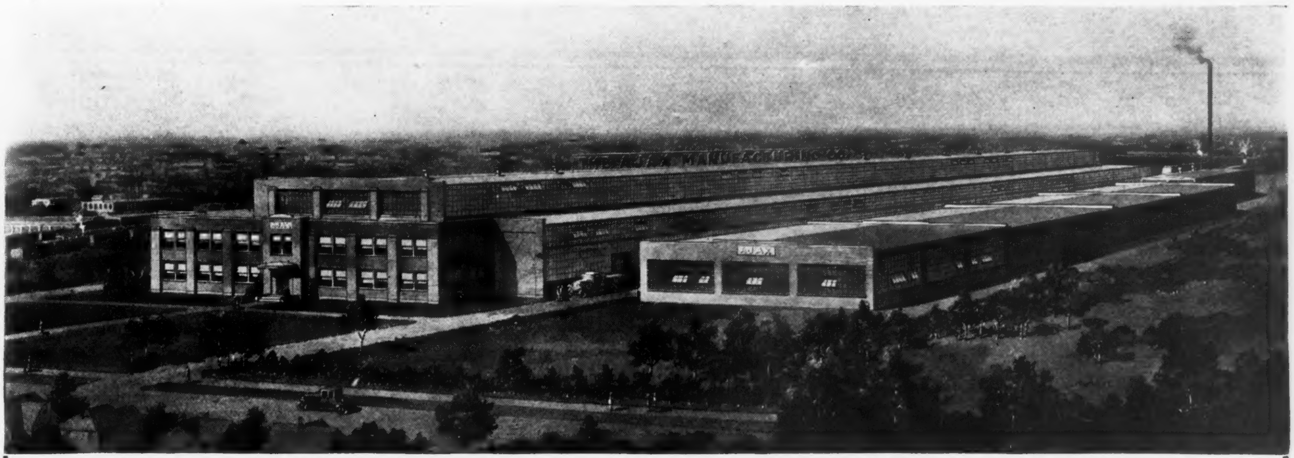


Type No. 1 — Straight

D	T			H
6	1/16	....	....	As ordered
6	....	....	1/8	
7	1/16	....	....	
7	....	....	1/8	
8	1/16	....	....	
8	....	....	1/8	
12	....	3/32	....	
12	....	....	1/8	

*Approved by Grinding Wheel Manufacturers' Association of the United States and Canada.

MACHINERY'S Data Sheet No. 64, New Series, August, 1925



Inviting Your Inspection of

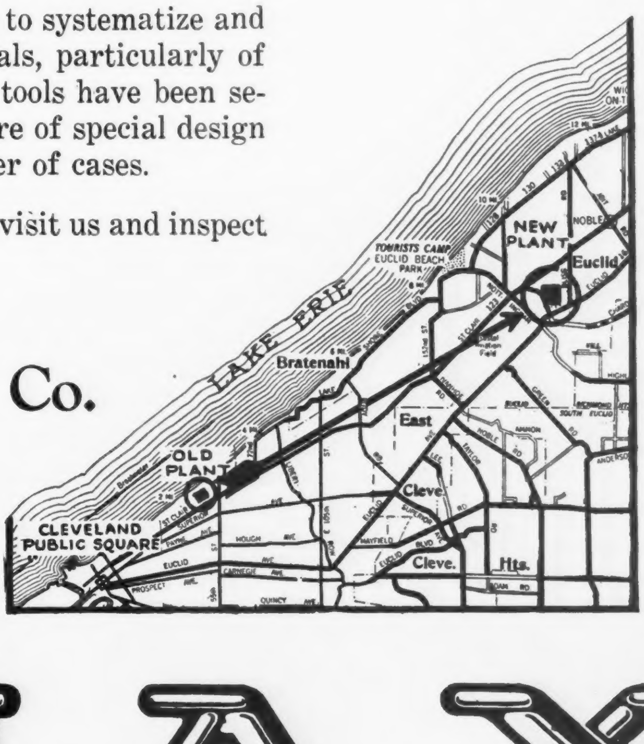
Our New Plant

WE take pleasure in announcing our removal to our new plant situated on Chardon Road between Euclid Avenue and the Nickel Plate Tracks, Euclid, Ohio, an easterly suburb of Cleveland.

This plant is designed for the efficient production of our complete line of Ajax Hot Metal Working Machines, based on our experience of more than thirty-five years in their manufacture. It offers us facilities never before available for more prompt and efficient service to our customers.

The shop layout is such as to systematize and reduce the handling of materials, particularly of heavy castings. The machine tools have been selected for high efficiency and are of special design for unusual service in a number of cases.

We cordially invite you to visit us and inspect our new establishment.



The Ajax Mfg. Co.

Euclid, Ohio

Offices:
621 Marquette Bldg., Chicago, Ill.
1369 Hudson Terminal, New York City

AJAX

TRADE MARK REG.

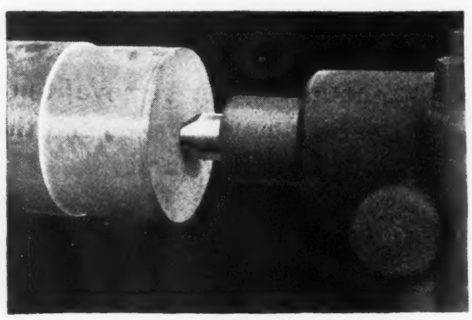
Where other metals wear out, Haynes Stellite goes right on

A GOOD lathe center must afford easy motion continuously. "Continuously" exactly describes the resistance of Haynes Stellite to wear. For Haynes Stellite lathe and grinder centers last four to six times longer than any others.

Haynes Stellite centers resist the abrasive action of chips and grit that are constantly ground against the center by the revolving piece; they reduce to a minimum the danger of burning off the point and ruining the work; they assure more accurate results and a greater final economy.

Maybe your plant does not need a metal which will resist abrasion. But what if that same metal resists heat, *and* corrosion, *and* magnetic action? What if it will not tarnish any more readily than gold and platinum? What if you can deposit it on wearing surfaces of other metals to double or triple the life of parts? What if it takes a high silver-white polish and retains it?

Can you use such a metal as that? If so, write or telephone our nearest District Sales Office at once.



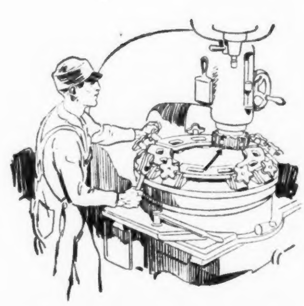
Three years ago an automobile manufacturer fabricated lathe centers from Haynes Stellite bar stock. Expensive as this method was, it proved profitable, for the Haynes Stellite centers he made outlived all others four to six times. The lathe center shown in the picture was developed after considerable experimenting. It may be obtained for far less than what the first ones cost this inventor. This center consists of a Haynes Stellite point welded to a shank of oil-hardened chrome nickel steel. It is ground, polished all over, and lapped true to close tolerances.

HAYNES STELLITE

- —is an intrinsically hard cast metal.
- —requires no heat treatment.
- —has temper that is inherent and permanent.
- —resists abrasion better than any other metal.
- —is not affected by heat up to 1800° F.
- —is tougher at red heat than when it is cold.
- —is highly resistant to almost all acids and chemical compounds.
- —has the untarnishable qualities of gold and platinum.
- —takes a high silver-white polish and retains it.
- —is non-magnetic and does not adhere to other materials

Work rests tipped with Haynes Stellite, used in centerless grinders, have a length of life in operation approximately five times that of those made of other metals.

Haynes Stellite resists wear. Gages of Haynes Stellite outlast steel 400% to 600%. Lathe and grinder centers show equal increases in length of life.



Haynes Stellite milling cutter blades are doing the bulk of the milling in the largest production shops in the world. They make milling machines pay bigger dividends— and decrease tool costs.

HAYNES STELLITE

HAYNES STELLITE COMPANY

District Sales Offices: Carbide and Carbon Building, 30 East 42d Street, New York
People's Gas Building, Chicago 4618 Euclid Avenue, Cleveland
General Motors Building, Detroit Balfour Building, 351 California Street, San Francisco

What the "Other Fellow" says—and does

This is page 26 of the Bausch & Lomb Booklet; shows an operator measuring cutting tools on the Contour Measuring Projector in the Pratt & Whitney plant. At the bottom of the page Columbia Phonograph pays tribute to this modern method of insuring accuracy in work and tools.

Read what these and other well known users have to say; see how they use the Contour Measuring Projector. Send for the booklet. Coupon is for your convenience—clip it now, before you forget.

Send for the Booklet.

Coupon is for Your Convenience—

Clip It Now Before You Forget.

BAUSCH & LOMB OPTICAL COMPANY, Rochester, N. Y.

BAUSCH & LOMB OPTICAL CO., 662 St. Paul St., Rochester, N. Y.

Gentlemen:—Please send me a copy of your Booklet as advertised in MACHINERY.

NAME ....FIRM ....

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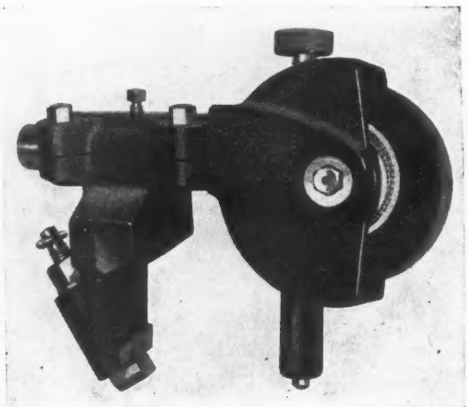
Watch Your Grind



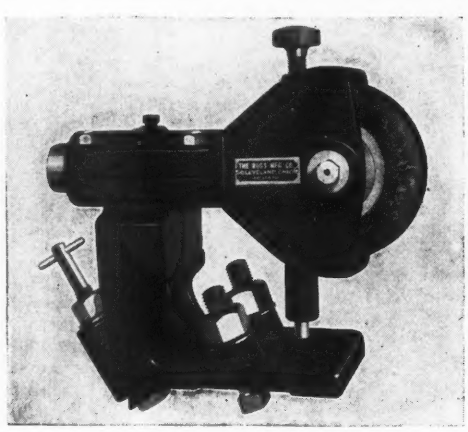
Ross Super-tool for NORTON 6", 10", 14", 16" and Type B Model 81 Grinders. *Eliminates diamonds.*

These Ross Super-tools the finish of a diamond—greater production per dress

THE Ross Super-truing Tool—most recent of Ross ball-bearing products—will give you all the grinding results of diamond dressing *at a fraction of diamond dressing costs.* For the most exacting work on crank-shafts, cam-shafts, axles, pins, bolts, etc., the Ross Super-tool not only replaces the diamond, but it trues wheels more quickly, with less care on the part of the operator, and it imparts a surface to the wheel that turns out more pieces per dressing.

The cost of the Ross Super-tool is less than that of a good stone. With only an occasional replacement of its abrasive wheel at a nominal price, it gives

Ross
Super-truing
Tools



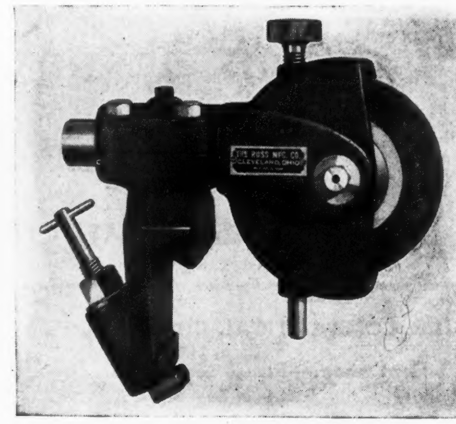
Ross Super-tool with special base for LANDIS 6",10",and 14"-16" Grinders. *Eliminates diamonds.*

Built for Precision and Ruggedness

THE Ross Super-tool, like all other Ross Dressers, is a ball-bearing device built for rugged strength combined with utmost precision. The spindle is hardened and ground, and all heat-treating is done in electric furnaces by the "Hump" (Leeds-Northrup) method, which guarantees uniform results.

Working parts of the Ross Super-tool are sealed against destructive grit by special slotted washers with an inlay of felt. The tool is equipped with the exclusive Ross spring, which takes up all end play of the revolving wheel, holds the dust washers firmly in place and keeps the tool in its original close-fitted condition.

The Ross Super-tool abrasive wheel is the product of long investigation and experiment by grinding engineers. The results obtained is proof of its quality.



Ross Super-tool for BROWN & SHARPE 10", 11", and 12" Grinders. *Eliminates diamonds.*

ing Costs Go Down

will true your wheels with do it more quickly—give you ing—cut dressing costs 50%.

years of efficient service, saving the initial cost many times over.

The Ross Super-tool clamps rigidly to the table of the grinding machine. It is mounted instantly without drilling of holes or other preparational work. An aligning slot in the sturdy shank of the tool automatically holds the abrasive wheel at a 10° angle—one of the distinctive features of the Super-tool. A steady-rest screw, bearing against the table of the grinder, eliminates any possibility of vibration. The Ross Super-tool is operated no differently than any other dresser.

Costing less than a diamond, guaranteed to true wheels with equal finish, giving years of service and paying for itself many times over in savings effected by its adoption, this Ross Super-tool should be on your grinders.—Then *"watch your grinding costs go down!"*

"NORMA" PRECISION BALL BEARINGS

go into every Ross tool. This is because Norma Bearings are finest for the purpose, measuring up to the standard of accuracy and ruggedness built into every Ross wheel-dresser.

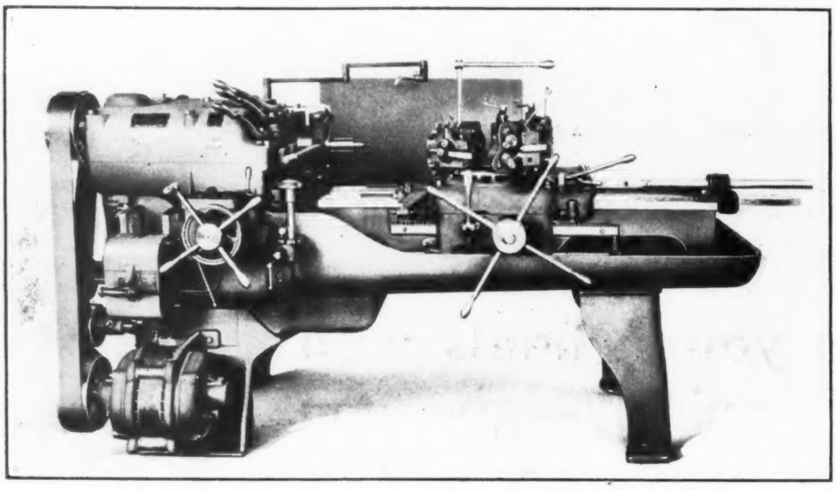
Other Ross Tools

THERE is a Ross ball-bearing tool to fill every wheel-dressing and truing need and it is a part of Ross Service to instruct your grinding men how to dress wheels more quickly, accurately and economically with Ross tools.

In shops all over the country these units are setting the standard for speed and economy in wheel-dressing. Our grinding engineers are ready to take up the question of applying Ross Tools to your particular work and to demonstrate in your own shop the great economies they will effect.

The Ross Mfg. Co. Cleveland, Ohio U.S.A.

J&L
TRADE MARK REGISTERED U.S.A.
JONES & LAMSON



J&L
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JONES & LAMSON

2¼ in. x 24 in. Hartness Flat Turret Lathe for Bar Work

Hartness Flat Turret Lathes — Hartness Automatic Die Heads
Fay Automatic Lathes — Flanders Ground Taps
Hartness Screw Thread Comparator

Jones & Lamson Machine Co., Springfield, Vermont, U. S. A.

Putting it on centers

The left hand holds the work—the right hand runs up the tail-center. Then—will the centers *fit* the holes in the work made to receive them?

If Cogsdrill Center Drills are used they *will*.

These center drills make perfect centers because their radial relief, ground after hardening, provides keen cutting edges. Their spiral chip chutes prevent clogging, breakage and damage to work. Their design insures accuracy; the patented process by which they are made guarantees long and satisfactory service.

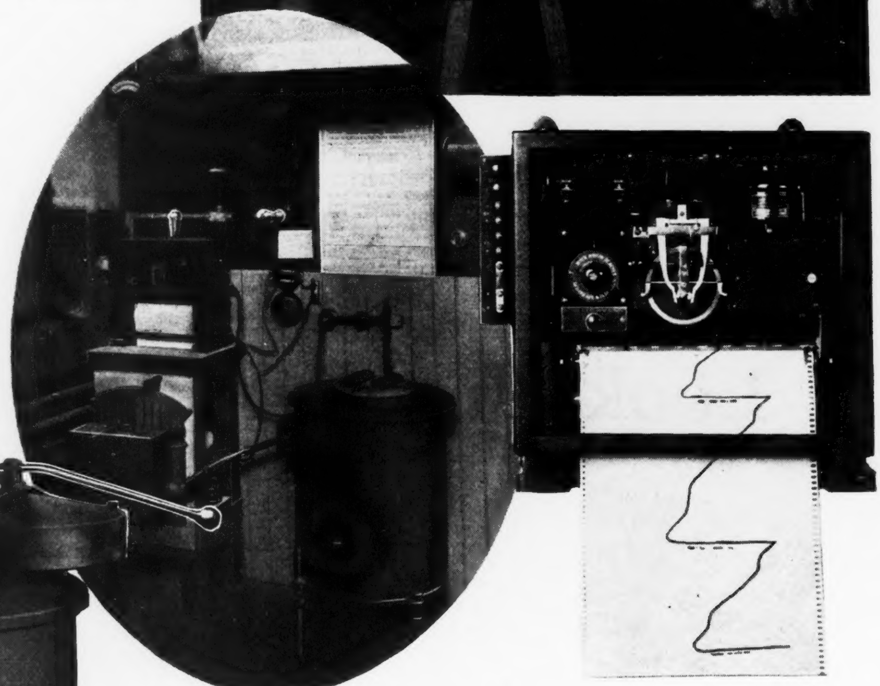
The Cogsdill Catalog shows why Cogsdrills drill perfect centers.

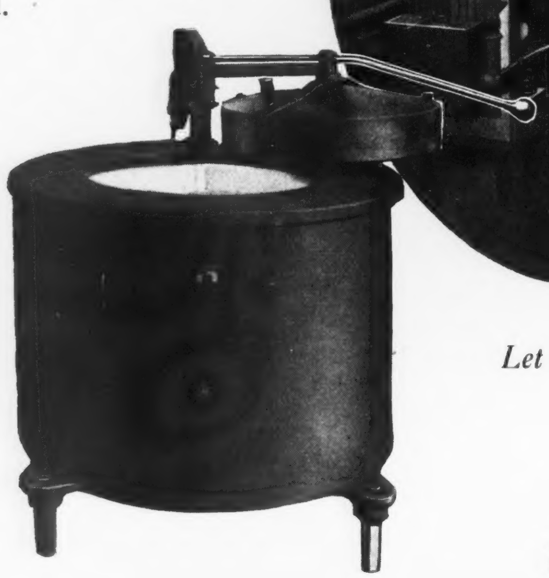
COGSDILL MFG. COMPANY, Detroit, Mich.

Contrast! *"Compass" Hardening— The Hump Method*

When the magnetic needle method of determining hardening temperature was first introduced nearly twenty years ago it was considered a great advance over the color guessing method universally used at the time. It had one big flaw, however, the hardener had no proof, after the piece being hardened no longer attracted the needle, that the temperature was not many degrees too high. Guess work, therefore, still played a large part.

Contrast this with modern heat treating. In the Leeds & Northrup Hump Method *all* factors are definitely under control. The hardener knows the quenching point, not as a temperature but as an exact time beyond the actual structural change in the steel. *There is no uncertainty*—no human element for which to make allowance. The rate and uniformity of furnace atmosphere are under perfect control.





Let us show you how modern industry is profiting by use of the Hump Method.

LEEDS & NORTHRUP COMPANY
4901 STENTON AVENUE, PHILADELPHIA
307 N. MICHIGAN AVENUE, CHICAGO
CHICAGO LOS ANGELES SAN FRANCISCO CLEVELAND
Electrical Measuring Instruments—Potentiometer Pyrometers—Hump Electric Furnaces

HUMP METHOD

L&N LEEDS & NORTHRUP

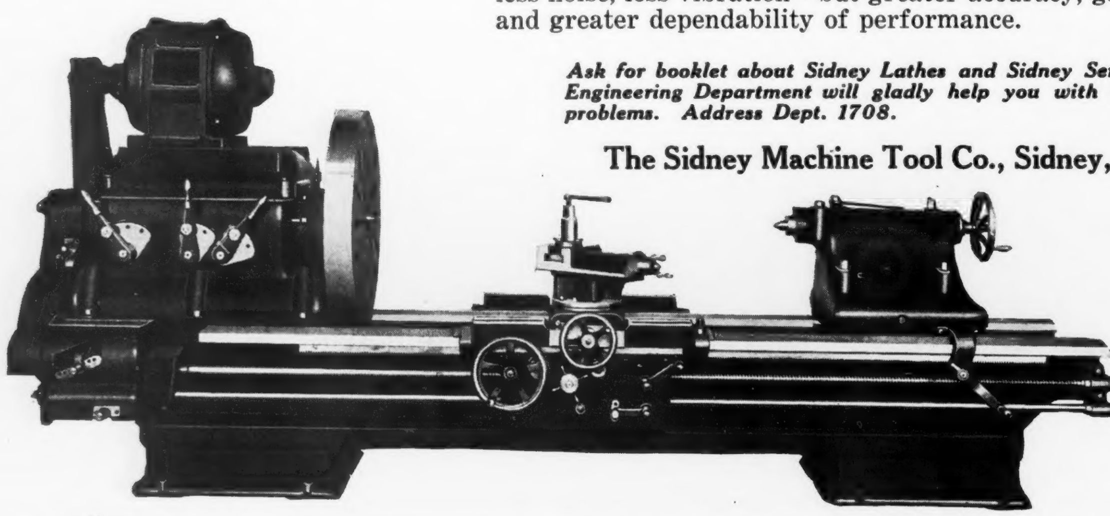
Sid says: "When You Say 'Sidney Service' You've said a mouthful"

The ability of Sidney Lathes to stand up under hardest service day-after-day has given them their reputation for dependability.

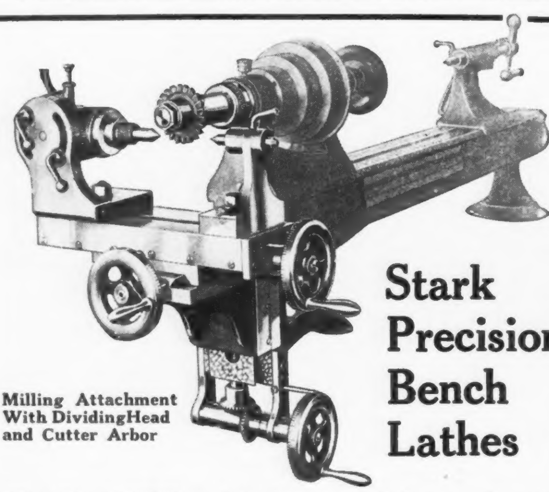
The 12-speed headstock of the Sidney 36-in. Heavy Pattern Lathe with its 13 gears, delivers a tremendous driving force, regardless of how heavy the work. Its design is in keeping with the highest Sidney standards—which means less gear breakage, less noise, less vibration—but greater accuracy, greater stability and greater dependability of performance.

Ask for booklet about Sidney Lathes and Sidney Service. Our Engineering Department will gladly help you with your lathe problems. Address Dept. 1708.

The Sidney Machine Tool Co., Sidney, Ohio



SIDNEY SERVICE **Sidney Lathes for every purpose** SIDNEY SERVICE



Milling Attachment With DividingHead and Cutter Arbor

Stark Precision Bench Lathes

The Stark Milling Attachment is but one of many efficient attachments that may be applied to Stark Lathes.

Its rigid construction allows the performance of a wide range of milling operations with the maximum of speed and precision.

The table working surface is 12" long by 4" wide, longitudinal feed 7", Cross feed 2", Vertical feed 4½". Feed screw hand wheels graduated in thousandths of an inch.

The dividing head allows for the accurate cutting of gears, fluting taps and reamers and other operations. It is equipped with draw-in spindle and takes same size wire chucks as the lathe spindle.

A swivel milling vise finely graduated in degrees, may be had for general work.

Our new catalog sent on request.

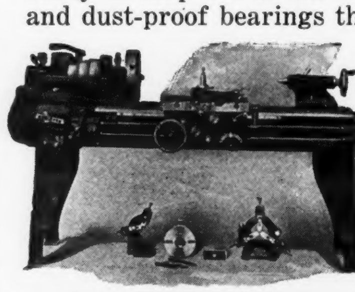
STARK TOOL COMPANY

WALTHAM Established 1862 **MASS., U. S. A.**

Originators of the American Bench Lathe

Rockford "Economy" Lathes

These machines are so accurate and versatile that they can be used exclusively for tool work; so rugged and productive that they are always ready to help out in the shop. Cut steel gears and dust-proof bearings throughout.



Thirty-two feed and thread changes; chasing dial and many other modern features. Four sizes, 12", 14", 18" and 22" swing.

Catalog on request

ROCKFORD LATHE & DRILL CO.

Rockford, Ill., U. S. A.

Steinle Turret Machine Co.

THE FULL SWING SIDE CARRIAGE

TURRET LATHE

STEINLE TURRET MACHINE CO.

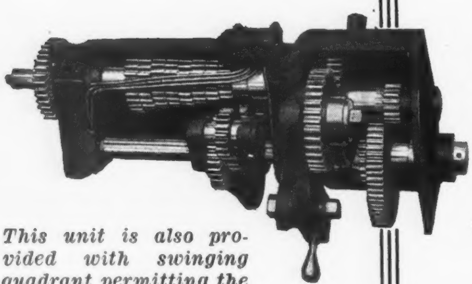
MADISON WISCONSIN U. S. A.

FLATHER LATHES

HIGHEST GRADE FOR TOOL-ROOM AND MANUFACTURING PURPOSES

The Flather Company, Nashua, N. H.

A Highly Developed Quick Change Mechanism



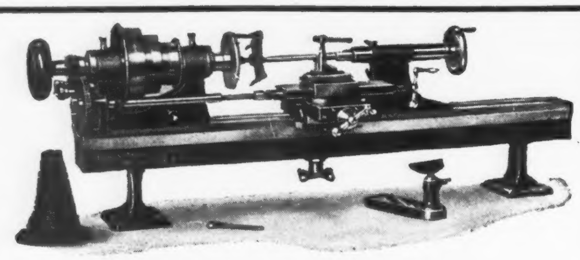
This unit is also provided with swinging quadrant permitting the use of additional gears for cutting special threads and worms.

The quick change mechanism of the "Lehmann Lathe" is of simplified construction providing a doubled range with the addition of only two gears:—two central driving gears of different ratios, each with an intermediate which engages the cone of gears. Drop the rocker arm, slide same on rocker shaft and one of the intermediate gears is thrown in mesh with the cone gears. Raise the rocker and the other intermediate gear is in use, obtaining the next set of progressive changes. All changes commonly used are made by movement of the rocker arm alone—greatly speeding the operation of the lathe.

A central oiling system lubricates all bearings in quick change gear box and rocker.

Send for catalog describing other features of the "Lehmann Lathe."

LEHMANN MACHINE COMPANY
3571 Chouteau Ave., ST. LOUIS, MO.



Almost a Complete Machine Shop

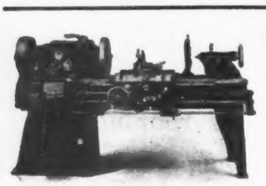
An Elgin Precision Bench Lathe with attachments is capable of turning, boring, drilling, milling, sawing, slotting, shaping, grinding, etc. Excels larger tools on production, is unexcelled for precision. Details on request.

ELGIN TOOL WORKS, Inc., ELGIN, ILLINOIS

CHAMPION LATHES

are substantial, strong, durable; handle a wide range of work; are accurate producers and cost reducers. Let us tell you all about them.

CHAMPION TOOL WORKS
4955 SPRING GROVE AVE., CINCINNATI, OHIO



Greaves-Klusman Lathes

Adapted to handle a wide range of work. Exclusive structural features eliminate all danger of twisting and bending the bed, of buckling or impairing alignment.

Thirty-five years lathe building experience in each G-K lathe. Made in 14, 16, 18, 20, 24 and 30 inch sizes.

The Greaves-Klusman Tool Co. CINCINNATI, OHIO, U.S.A.

A Masterpiece in a Back Geared Precision Lathe

The lathe that will enable you to solve those unusual lathe problems whether they be in the

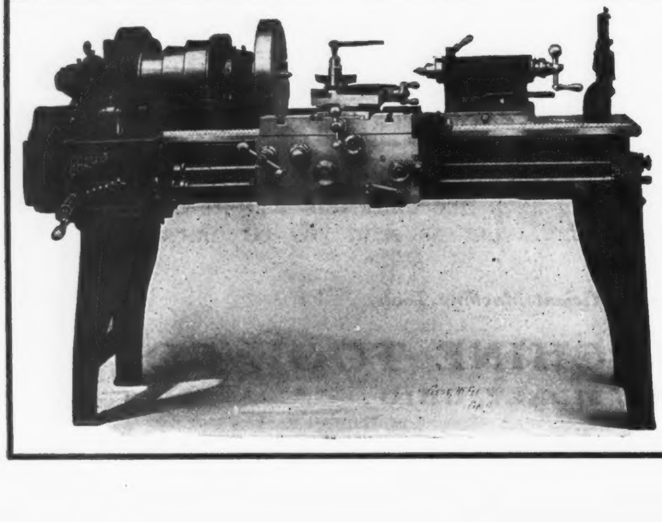
Laboratory, Tool-room or Manufacturing Departments

Complete in its attachments; easy in its manipulation; exact in its cutting.

May we send you our Catalog?

Rivett
LATHE AND GRINDER CORPORATION
BRIGHTON DISTRICT OF BOSTON MASS

The old masters of the art of toolmaking



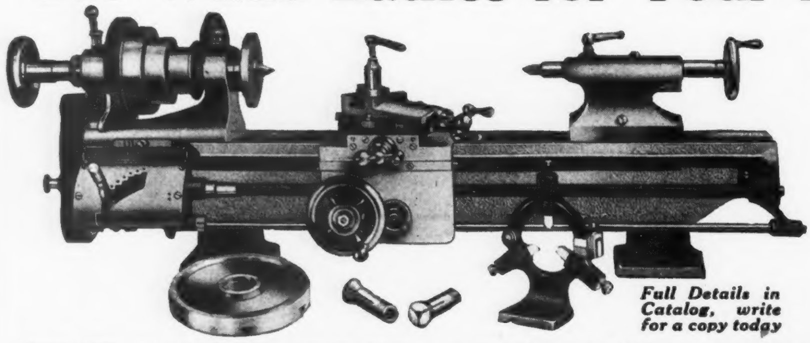
The Complete Catalog of Bradford Lathes

Shows a line of Engine, Precision and Turret Lathes in sizes from 14 to 42 inches. Well built, wide range machines to give highly profitable service on all classes of production manufacturing and special work.

Send for a copy.

The Bradford Machine Tool Co.
CINCINNATI, OHIO, U. S. A.

Use Wade Lathes for Your Precision Work



Full Details in Catalog, write for a copy today

whether it is manufacturing, for tool or experimental work. If it comes properly within the class of Precision Work it is done with the greatest economy on a Wade Lathe.

We have Attachments and Methods that enable you to perform any conceivable operation and to do it to advantage. Investigate our way.

THE WADE TOOL COMPANY, 49-59 River St., Waltham, Mass.

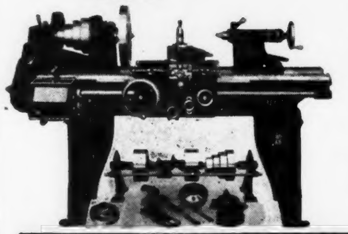
Heavy Feeds
Big Production
No Chatter

The Briggs Solid Arch Support is the best possible insulator against vibration and chatter. It's the secret of Briggs Miller production, which is accurate with even the coarsest feeds. Let us acquaint you with the Briggs Miller—send for our catalog. We'll also be glad to estimate Briggs time on your work.

GOOLEY & EDLUND, Inc., Cortland, N.Y.

Pay Less for LATHES of Highest Quality

Built on the
SOUTH BEND
Standardized Production Plan



South Bend Lathes are modern lathes—built in quantities and brought down in price by modern manufacturing methods. They are as outstanding in quality, accuracy and performance as they are in price.

Write for Catalog No. 84

South Bend Lathe Works
717 E. Madison St.,
SOUTH BEND, IND.

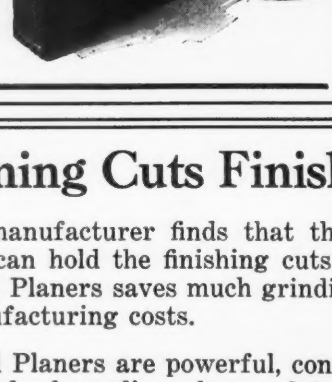
EASY PAYMENTS IF DESIRED

Cleveland Open Side Planers

DON'T EXPERIMENT

26" to 72"

Buy the combination of our 25 years' experience and the opinion of over 1,000 satisfied users.



Counterbalanced Side Heads, Ball Bearing Countershafts, Aluminum Drive Pulleys, Self-Oiling Bushings throughout the Drive.
Box Tables, Tool Box in Bed.

Send for Descriptive Circular

The Cleveland Planer Co.
Established 1900
3148 Superior Avenue
CLEVELAND, OHIO

SUPER-QUALITY THREADS

One of our customers has a 4" pipe thread in a forging which has to be absolutely tight at 1000 lbs. pressure. He is now milling them on a Smalley General Thread Miller at less than one-fifth the cost and the rejections are almost eliminated. Threads are important. Why put up with a medium quality when an excellent quality can be obtained at less expense. Quality in every detail makes selling easier. Add quality threads. Send us your threading problems.

SMALLEY-GENERAL COMPANY
BAY CITY, MICH.

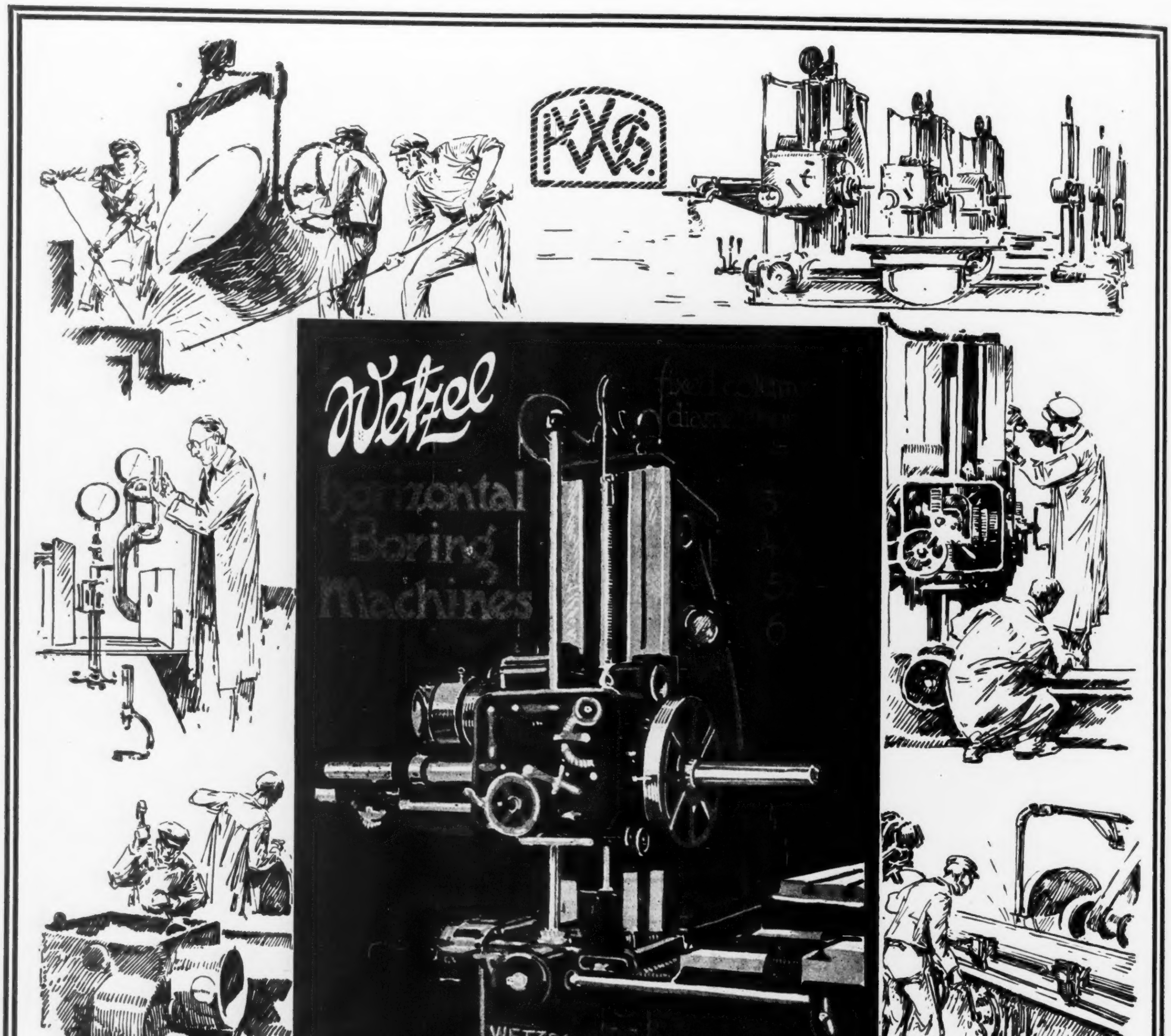
Accurate Planing Cuts Finishing Costs

A big machinery manufacturer finds that the close limits to which he can hold the finishing cuts on his Woodward & Powell Planers saves much grinding and so reduces his manufacturing costs.

Woodward & Powell Planers are powerful, convenient and *accurate*. Standard, medium, heavy duty types, belt or motor drive; send for details.

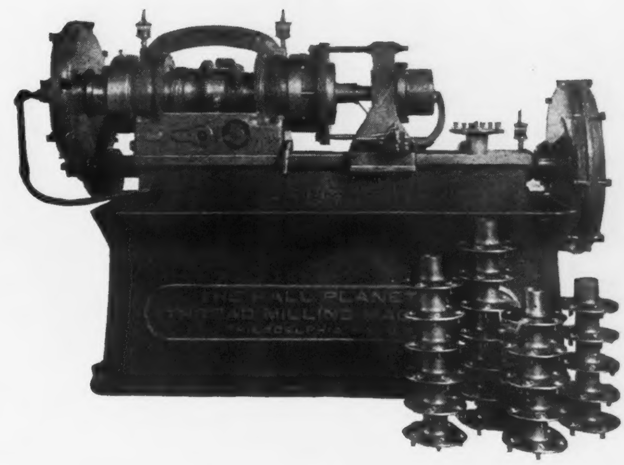
Woodward & Powell Planer Co.

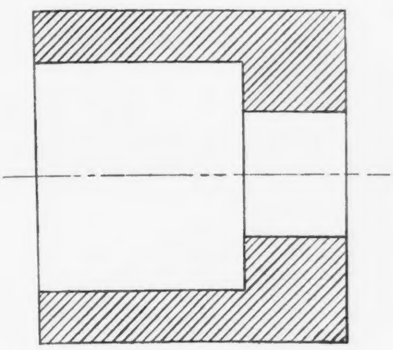
Worcester, Mass., U. S. A.

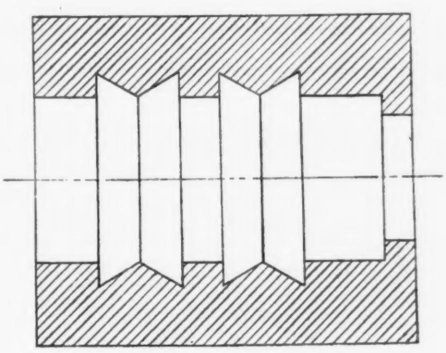

Wetzel
Horizontal
Boring
Machines
WETZEL
Karl Wetzel
Gera-R.
Germany.

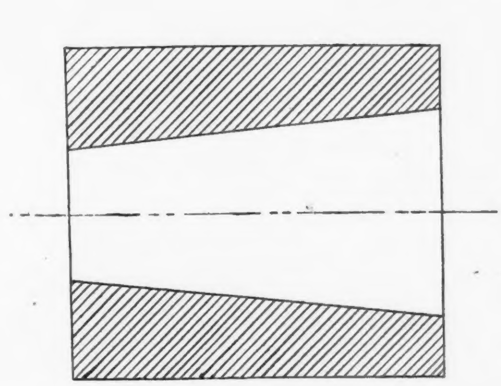
PLANAMILLING

To Machine Any Hole in One Setting









HERE are drawings for three holes; how would you machine them and what would the operation cost? The tapered hole is simple; machining the two diameters requires two careful settings to insure accuracy and concentricity; but the third hole presents a machining problem that takes an expert mechanic many hours of careful work to solve.

In the plant equipped with a Planamill the hole with eight diameters is as easy to machine as the hole of a single diameter. The operator chucks the work, starts the cutting tool and the operation proceeds. *All diameters are finished without resetting* as accurately as you wish and absolutely concentric.

Planamilling is the simplest method of machining holes of any size from 1″ to 10″ diameter, any number of diameters and any form.

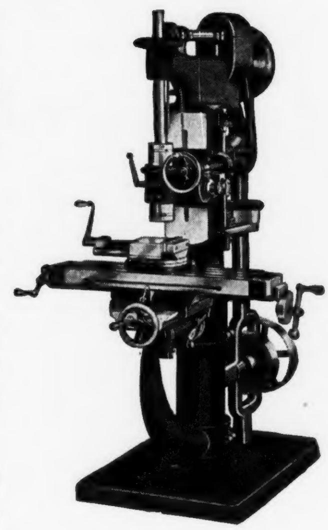
Send blueprints for estimates on production time and costs; they will give you interesting material for comparison.

THE HALL PLANETARY COMPANY

Fox St. and Abbotsford Ave., Philadelphia, Pa.

AGENTS: Detroit, J. C. Austerberry, Cleveland, The Cleveland Duplex Machy. Co., Inc. Rochester, N. Y., Ogden R. Adams Co., Inc. New York City, Triplex Machine Tool Corp., 50 Church St. Chicago, Neff, Kohlbush & Bissell.

Mill at any angle without rechucking



Expensive fixtures are unnecessary when a Knight Miller does your work. With this machine you can mill and drill at any angle without rechucking.

Work is simply clamped to the table and table tilted to the desired angle.

Knight Millers are unsurpassed for convenience and accuracy in making dies, jigs and fine tools.

Let us show you what the Knight Miller can do for you.

W. B. KNIGHT MACHINERY CO.

3920 W. PINE STREET, ST. LOUIS, MO., U. S. A.

FOREIGN AGENTS: The Coats Tool Machine Co., Ltd., London, England; Yamatake Company, Tokio, Japan.

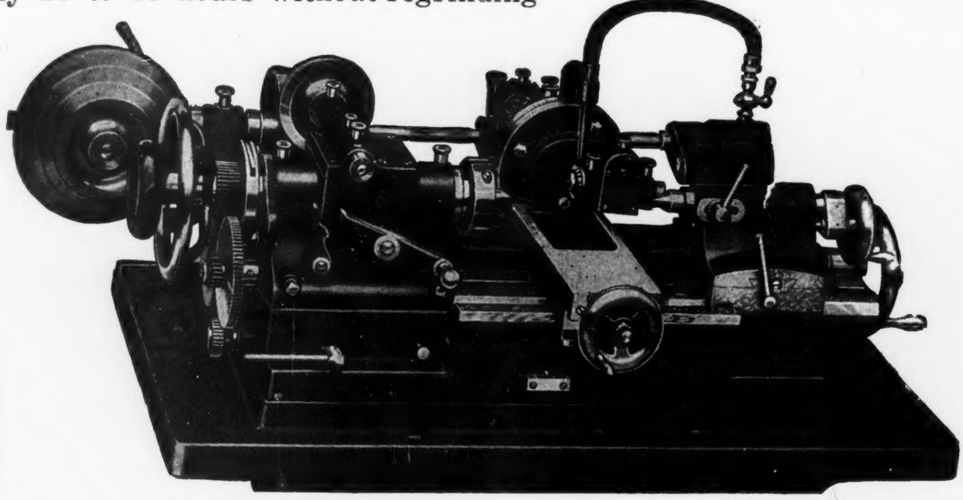
KNIGHT MILLER

Skilled Operators Not Necessary

Skilled operators are not necessary to run Waltham Thread Milling Machines—these machines can be operated singly or in battery by ordinary labor. Manufacturers of products requiring small, accurate screw threads of uniform lead and size use these machines continuously 10 to 15 hours without regrinding the cutters.

One cut is usually sufficient to complete each thread. All kinds of threads may be cut—inch or metric pitch.

Let us send full information

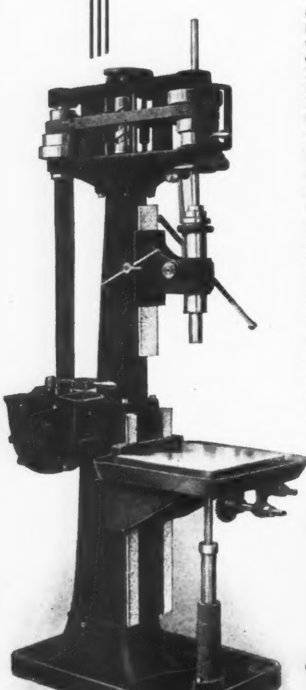


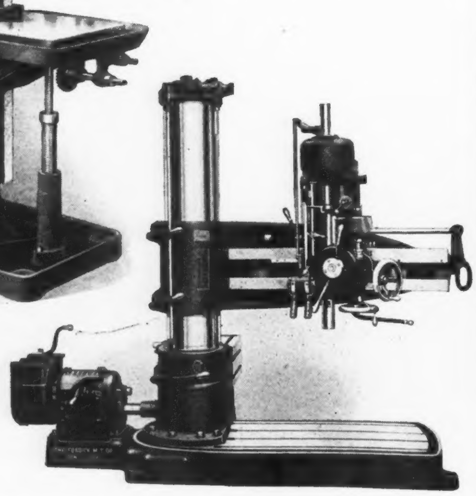
WALTHAM
TRADE MARK
REGISTERED U.S. PAT. OFF.

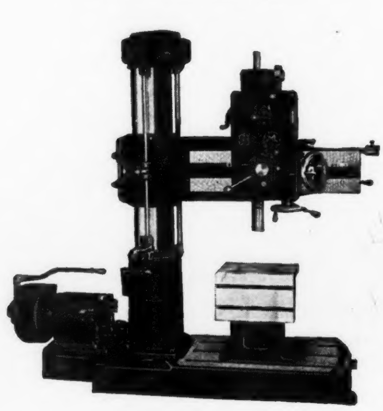
WALTHAM MACHINE WORKS, Newton Street, Waltham, Mass.

Small Thread Millers, Gear Cutters, and other small Automatic Machines

Waltham Thread Milling Machines







I-R Long Stroke Pneumatic Drills

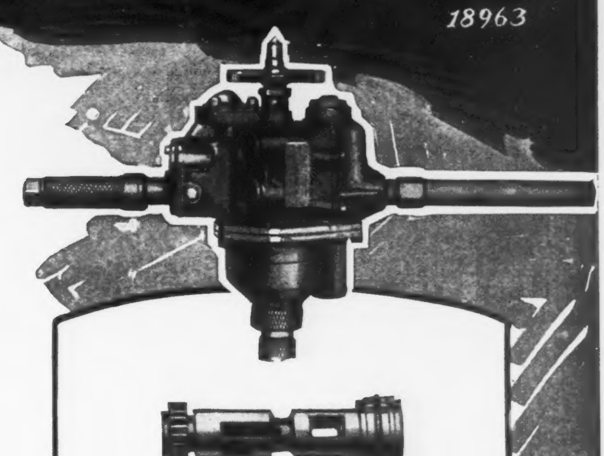
The only air drills with speed governors

Why tapping costs are now reduced

A centrifugal governor on each four cylinder Ingersoll-Rand drill prevents racing the machine beyond a safe working speed for either the machine or the staybolt tap.

In tapping it prevents damage to the tap at the hump and helps make better threads. It reduces air consumption and avoids wear and tear on the drill parts.

It prevents racing when a drill is underloaded and so avoids injurious high speeds, excessive friction heat and burning of the lubrication. The crank and connecting rods do not receive the strains present in a machine without a governor.



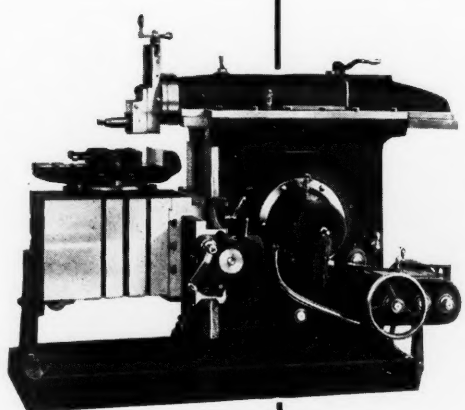
The above shows the centrifugal speed governor mounted on end of main valve.

INGERSOLL-RAND COMPANY, 11 Broadway, NEW YORK CITY
Offices in principal cities the world over.
FOR CANADA REFER CANADIAN INGERSOLL-RAND CO., LIMITED, 260 ST. JAMES STREET, MONTREAL, QUEBEC

Ingersoll-Rand

Columbia Superior Shapers

Fast—Powerful—Accurate



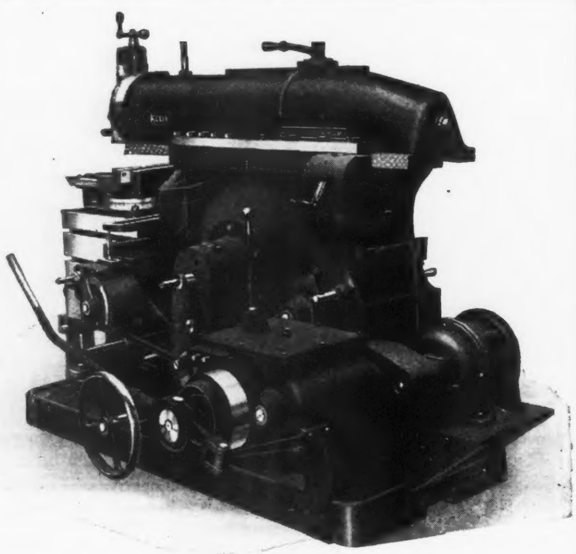
Shapers that meet the demands of tool room work and manufacturing operations, that are profitable in contract and repair shops.

Quick stroke adjustment, quick change feed, improved rail clamp, special driving cone construction are special advantages in these machines.

Cut shows machine with speed Box, Friction Clutch and Brake and Single Pulley Drive; also built with Cone Pulley or Motor Drive, 16" to 36" sizes. Send for complete details.

The Columbia Machine Tool Co., Hamilton, Ohio

Manning, Maxwell & Moore, Inc., Selling Agents, New York City and branches—Atlanta, Boston, Buffalo, Chicago, Cleveland, Detroit, Houston, Philadelphia, Pittsburgh, San Francisco, S attle, St. Louis, Syracuse.



Kelly Crank Shapers

The investment value of the Kelly figures high—there's a positive income to be derived from its use. The Kelly is a modern machine tool in every respect. Recent improvements have greatly promoted convenience of handling. Interesting construction details include square ways for ram, large wearing surface on crank bearing, tilting table, motor drive, swivel vise, etc.

MAY WE SEND DETAILS?

The R. A. Kelly Company

XENIA *Makers of Crank Shapers Only.* **OHIO, U. S. A.**

Broaching Machines and Broaches

Years of experience in the successful manufacture of broaching equipment assure you of up-to-date, progressive methods and tools when you buy broaches or broaching machines from J. N. Lapointe Co. of New London.

We'll be glad to quote costs and give you complete information on any broaching proposition.

J. N. LAPOINTE CO. *of* New London, Conn.

Shapers Exclusively

Crank Sizes: 12", 14", 16", 20", and 25"—Either Cone Driven or through Speed Box, 32" B. G. All Geared Single Pulley Drive

THE SMITH & MILLS COMPANY

CINCINNATI OHIO, U. S. A.

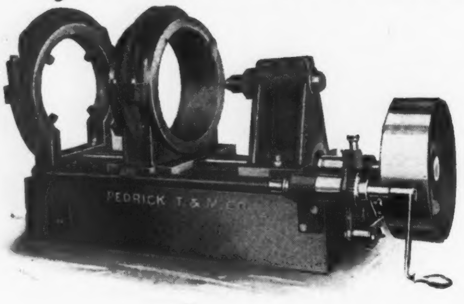
Make your drilling profitable with

HOEFER DRILLERS

Take advantage of the "minute-saving" features of Hoefer Drillers and Auxiliary Heads.

HOEFER MFG. CO., Freeport, Ill.

Why Dismantle to True, Turn, Rebore Heavy Machinery?



The Pedrick Portable Turning Machine goes to the job—all set. Turns shafts, axles, rolls; trues crank pins; rebores crank pin holes, etc. Accurate. Quick. Convenient. A great time saver. Several sizes to meet all requirements.

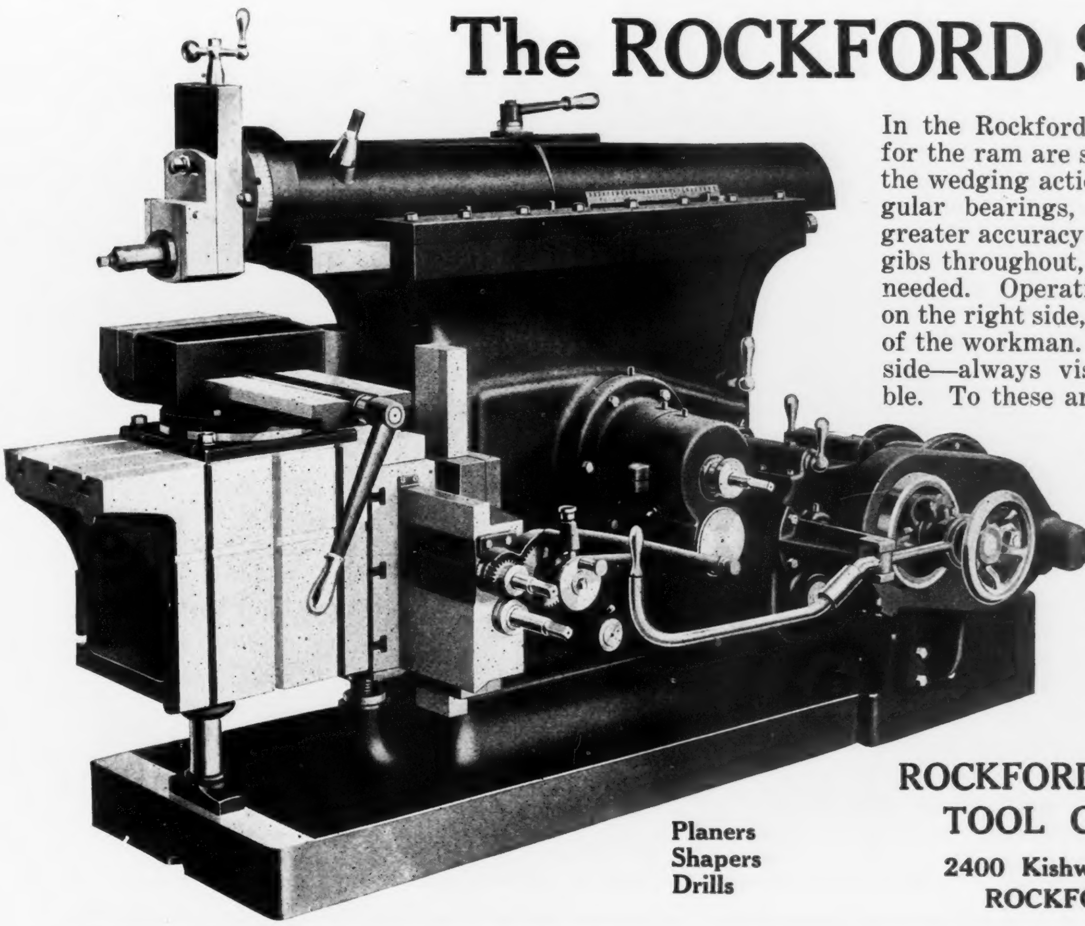
Write for details

Pedrick Tool & Machine Company

3639 N. Lawrence Street PHILADELPHIA

Manufacturers of Portable Boring, Milling and Pipe Bending Machinery and Floor Boring Machines

The ROCKFORD Shaper



In the Rockford Shaper bearings for the ram are square, preventing the wedging action frequent in angular bearings, and maintaining greater accuracy. Full length taper gibs throughout, adjustable where needed. Operating levers are all on the right side, within easy reach of the workman. Oil cups are outside—always visible and accessible. To these and to all other details the utmost thought and skill have been applied, making a shaper we are proud to sell—and the purchaser is proud to recommend.

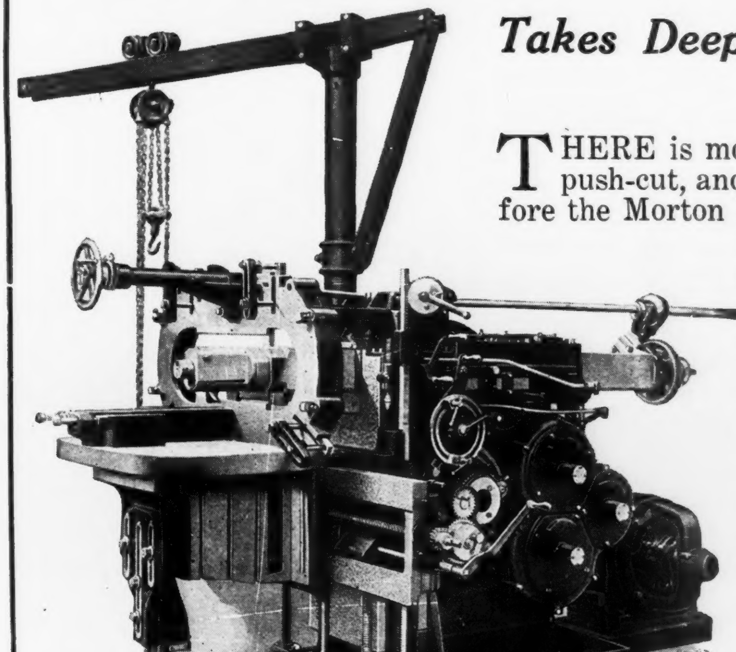
Send for the circular

Planers
Shapers
Drills

ROCKFORD MACHINE TOOL COMPANY

2400 Kishwaukee Road, ROCKFORD, ILL.

The Morton Draw-Cut Shaper



Takes Deeper, Smoother, More Accurate Cuts

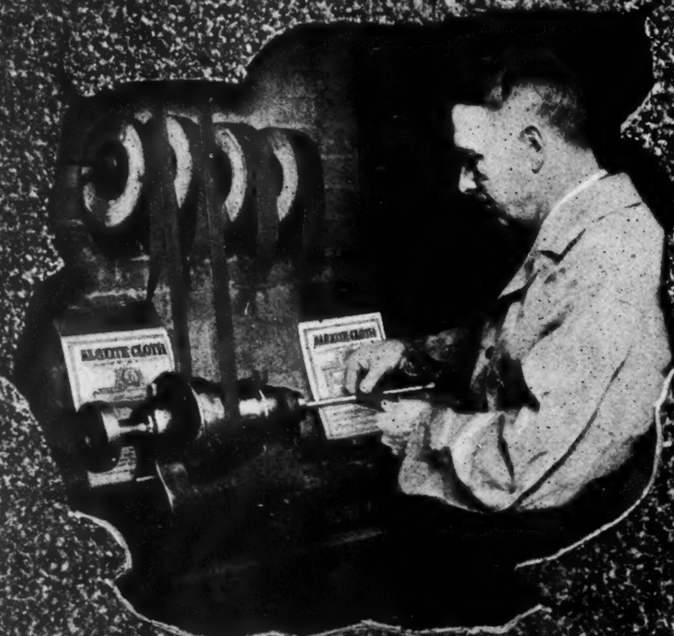
THERE is more power in a draw-cut than in a push-cut, and less strain on the machine—therefore the Morton Draw-Cut Shaper is more compact in construction than a push-cut shaper and consumes about one-third less power.

Setting up and operating conveniences make it possible to perform a variety of operations in one setting —cutting handling costs and insuring greater accuracy on complicated operations.

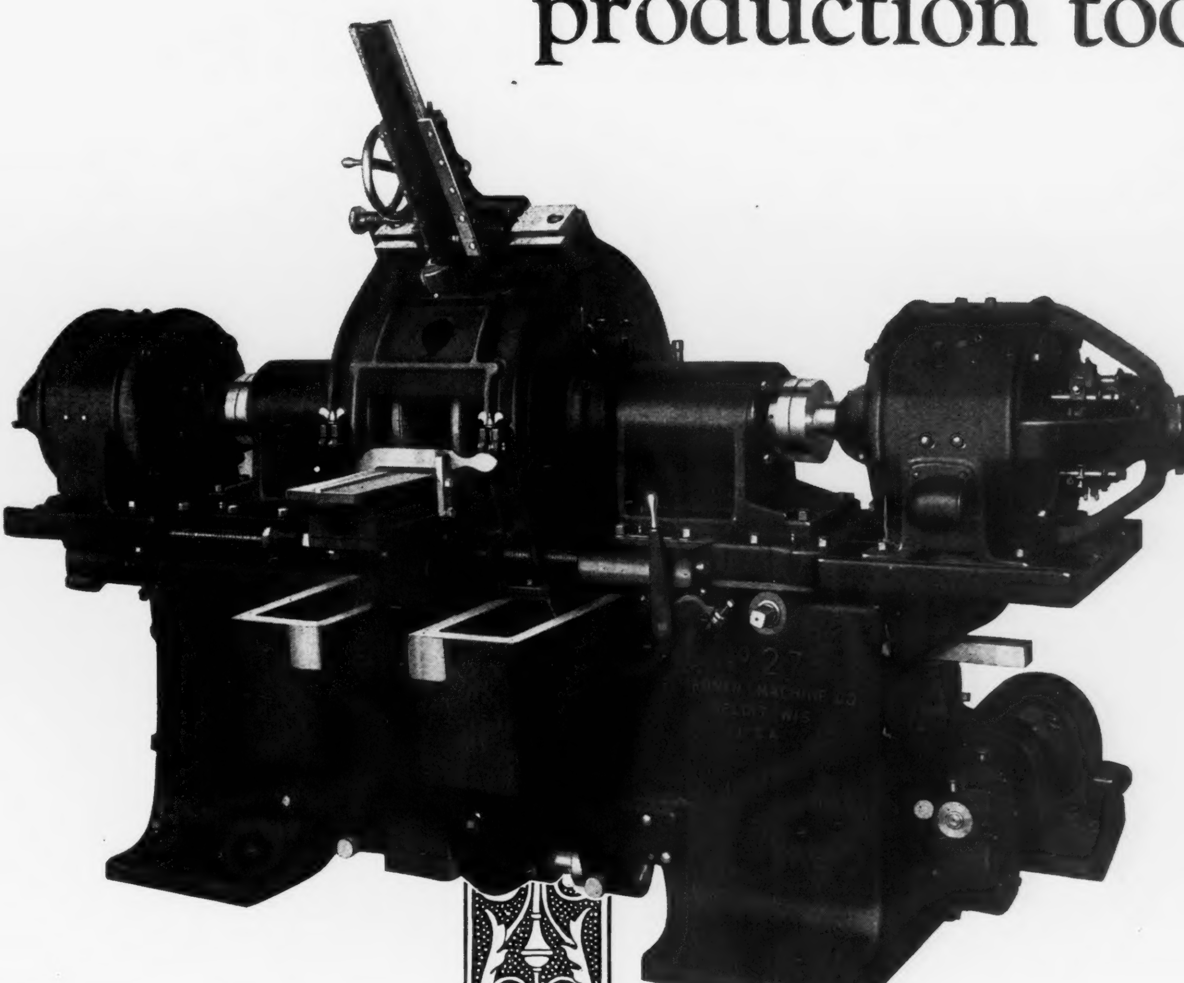
Morton Draw-Cut Shapers and Planers are production machines for modern industrial and railroad shops. Ask about them.

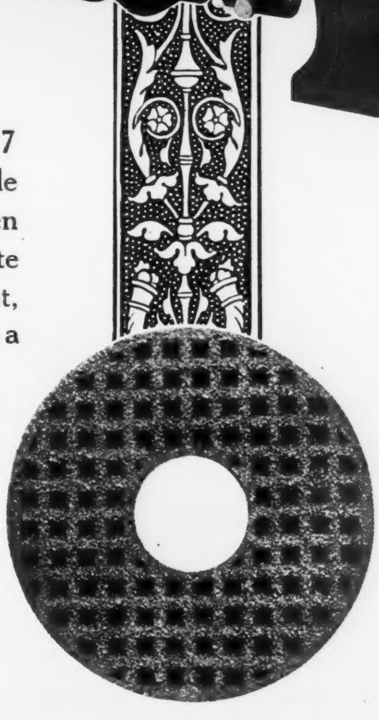
Morton Mfg. Company

MUSKEGON HEIGHTS, MICHIGAN, U. S. A.


ALOXITE CLOTH

A massive, powerful production tool





THE new Gardner No. 27 OIL GEAR FEED Double Spindle Disc Grinder has been redesigned to accommodate longer work. It spells efficient, economical production upon a great many large parts with opposite parallel flat surfaces of approximately equal area.

Ask for Circular and for New G. I. A. Disc Folder!

THE other half of the production story is the heavy-type

Gardner G. I. A. Disc

illustrated below. The unequalled cutting and lasting qualities of this product, in both Standard and Deep-Corrugated types, are largely responsible for the great productive possibilities of this, as of all Gardner Grinders.

GARDNER MACHINE COMPANY

414 E. Gardner St., Beloit, Wis., U. S. A.

GARDNER DISC GRINDERS

"Abrasive" Borolon Wheels

Keep H. S. Steel Tools "Just Right"

"Abrasive" Borolon Grinding Wheels keep the H. S. steel tools sharp in this ship and engine building plant. They stand up well to a difficult grinding job; big H. S. steel tools are not easy to grind, but as usual the *right* "Abrasive" Wheel stands up to the job better and lasts longer than other wheels they have used.

"Abrasive" Grinding Wheels in various other departments in this plant have given equally profitable service; they have been used for a number of years.

"Abrasive" Grinding Wheels are profitable for use on everything from snagging castings to the finest grinding.

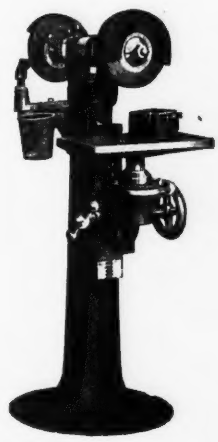
Tell us what you grind—our experts will select the wheel that will make the job pay best. Catalog?

Borolon
TRADE MARK
and
Electrolon
TRADE MARK

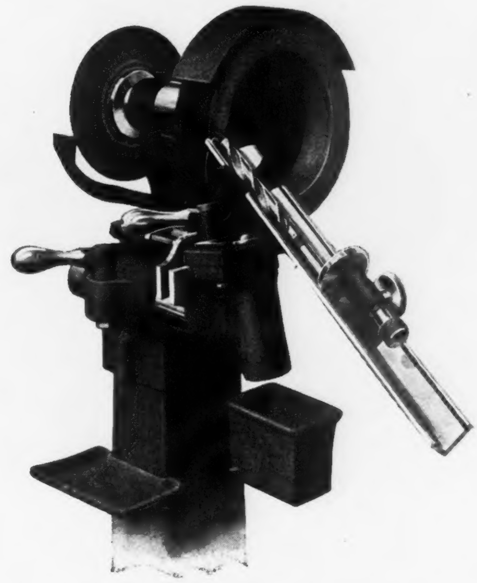
TRADE ABRASIVE MARK
REGISTERED

ABRASIVE COMPANY

Bridesburg 566 W. Washington Blvd., Chicago **Philadelphia**



Grind in 1925 with
LA SALLE GRINDERS



This No. 1 Plain and Surface Grinder with micrometer adjustment is a good grinder for general shop and tool-room use.

Height to spindle center....40"
Distance between wheels....15"
Spindle bearings...1 1/16 x $3\frac{1}{2}$"
Size of pulley.......$3\frac{1}{4}$ x $2\frac{1}{8}$"

The No. 3 Plain and Surface Grinder is a good machine for general grinding work which requires a large rigid machine, also furnished for wet grinding.

Grinding wheels ....12 x 1"
Distance between wheels....25"
Working surface of table 7 x 24"

Longitudinal movement ....24"
Traverse movement ....8"

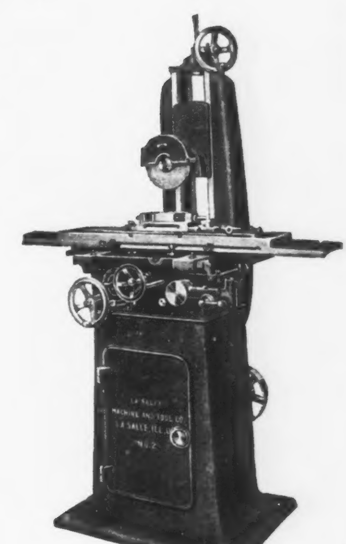
The American Twist Drill Grinder will grind your drills **right,** either straight or oversized shank drills. A boy can run it, and no chance for him to go wrong.

The American Drill Grinder sharpens drills from $\frac{1}{8}$" to $3\frac{1}{2}$". For wet or dry grinding.

Speed of wheel spindle, 1700 R P.M.
Speed of counter....425 R.P M.
Height of machine.........49"
Floor space..........25" x 40"

These are just a few of the La Salle line of Grinders. They are satisfactory in operation and reasonable in cost.

Write for circulars completely describing La Salle Grinders.



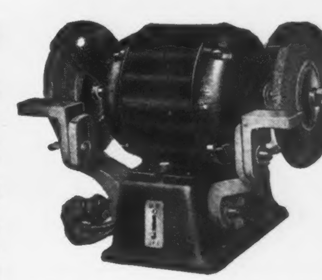
The No. 2 Automatic Surface Grinder is very effective for grinding dies, punches, and small tools. Also furnished for Wet Grinding and Motor Drive. Using a 7" wheel, the vertical spindle travel is 10".

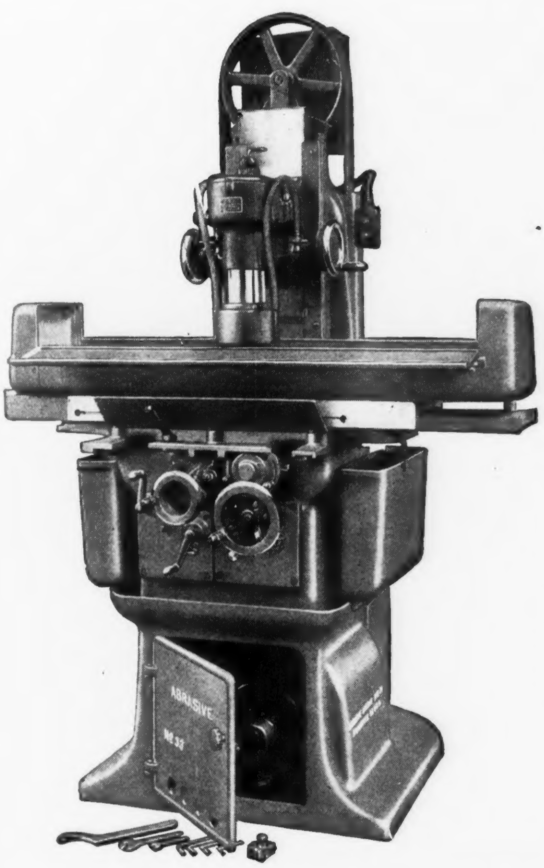
Will grind work 20" long and 6" wide.

LA SALLE TOOL COMPANY

LA SALLE, ILLINOIS, U. S. A.


RANSOM MFG. CO.
OSHKOSH, WIS.
U.S.A.





ABRASIVE

Abrasive Surface Grinders are ideal machines for tool-room, shop or factory. They're accurate, versatile and productive, meeting requirements for all except the largest classes of surface grinding.

As an example of the care with which these machines have been developed, take a look at the motor drive. Enclosed in the base, thoroughly protected, easy of access, drive direct to spindle by leather belt which is entirely encased to top of machine.

And this is one only of the many features of Abrasive design we'd like to tell you all about. Write us.

Abrasive Machine Tool Company
East Providence, R. I., U. S. A.

The Diamo-Carbo Emery Wheel Dressers

Cost little, keep wheels right. A satisfactory substitute for diamond tools. Let us send you one on trial!

Send for the price list of Desmond-Stephan wheel dressing tools, Huntington, Sherman, magazine, etc., standard or special tools. Diamonds in stock for selection.

The Desmond-Stephan Mfg. Co.
URBANA, OHIO

New England Representative, George L. Gaylord, Westfield, Mass.
The Canadian Desmond-Stephan Mfg. Co., Ltd., Hamilton, Ont.
Alfred Herbert, Ltd., Coventry, England, Agent for Great Britain.

Emery Wheel Dressers

Two Sizes — **CUTTERS** — Nos. 1-2

We make the regular Huntington (Pattern) for all sizes.
Roughing for Nos. 1 and 2. Paragon for No. 1 only.

GEO. H. CALDER CO., Lancaster, Pa., U.S.A.

INDUSTRIAL DIAMONDS

Only good diamonds well selected for quality and proper weight for work required of them, then properly mounted will give maximum service.

Tools Made of Diamond

With thirty years experience in handling diamonds and making special shape diamond tools, we know we can satisfy your every want at the minimum cost.

ACME DIAMOND TOOL CO., 170 Broadway, New York

Grind your Drills on an Oliver Drillpointer !

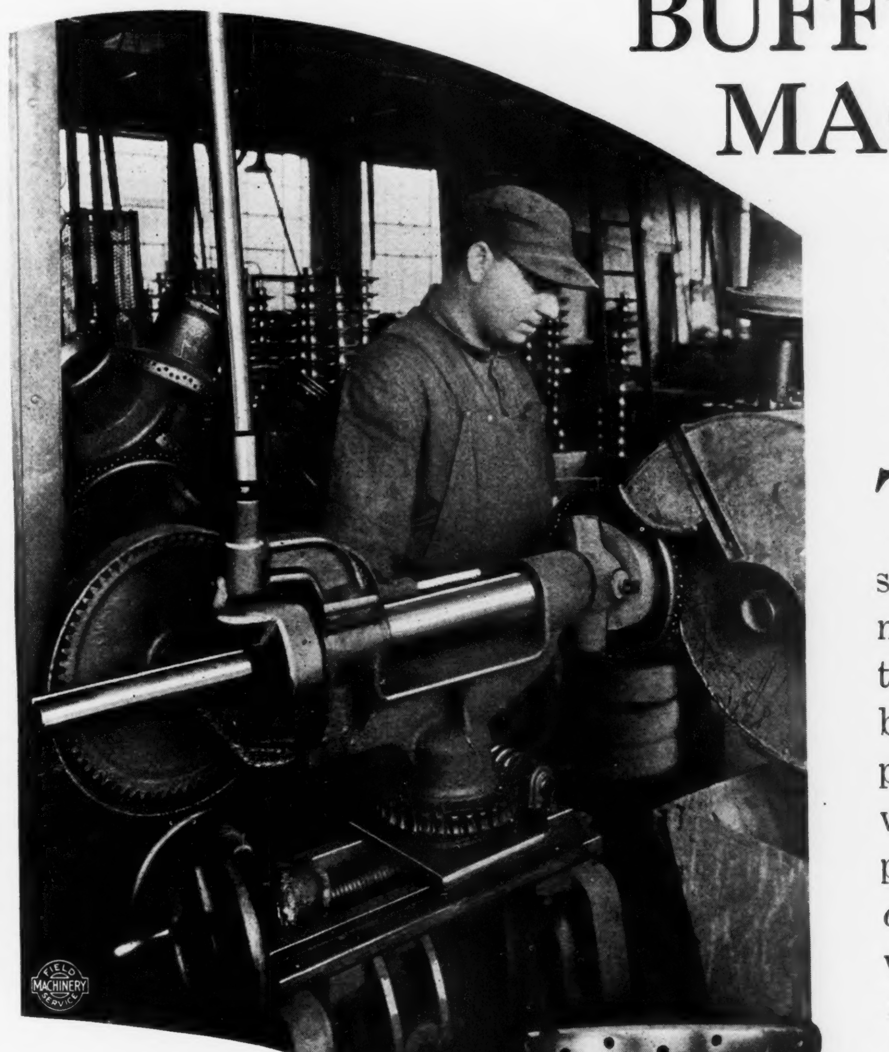
AN OLIVER OF ADRIAN PRODUCT

It is the pronounced *hook* at the center of drills ground on the Oliver Drillpointer that permits maximum feeds and speeds; requires much less power; gives more holes per grind; drills close to size; increases number of grinds per drill; reduces wear on drilling machines and solves many other drilling problems. This *hook* gives proper clearance to the cutting lips and permits the chisel point to cut its way without the slightest drag.

Let us grind a few of your drills for proof.

OLIVER INSTRUMENT COMPANY
1410 East Maumee St. ADRIAN, MICH., U. S. A.

AUTOMATIC BUFFING MACHINES



Twice as Fast as Hand Polishers on Auto Hubs

THIS operator rough and finish polishes seventy hub shells in a nine hour day — just twice as many as the best he could do by hand polishing. He gets higher wages (because of better production) yet *the shells cost one third less* than when hand polished.

Automatic Buffing Machines always pay—customer's records show that they usually pay for themselves in from three weeks to three months. Operators like them because absolutely uniform finish means no "rejects" —while greater production, as in this case, usually means more pay.

Polishing range is astonishingly wide—if you polish anything in quantity let's see if it can't be done on an Automatic Buffing Machine.

AUTOMATIC BUFFING MACHINE CO.

Chicago and Perry Streets BUFFALO, NEW YORK

POSITIVE PROOF

That Landis Will Reduce Costs

Before spending your money for new equipment you should know just what returns you will get from your investment. You will want to get a dollar's worth of results for every dollar you spend.

In every installation the Landis Roll Grinding Machine is reducing the cost of resurfacing all types of rolls. The following example shows what one steel company is saving:

Former cost	**$2.97**	**per roll**
Landis cost	**.94**	**per roll**
Saving	**$2.03**	**per roll**

They are resurfacing from 40 to 50 rolls per week giving them a return of 100% on their investment.

Investment is measured by its income. Modern machine tools are good investments.

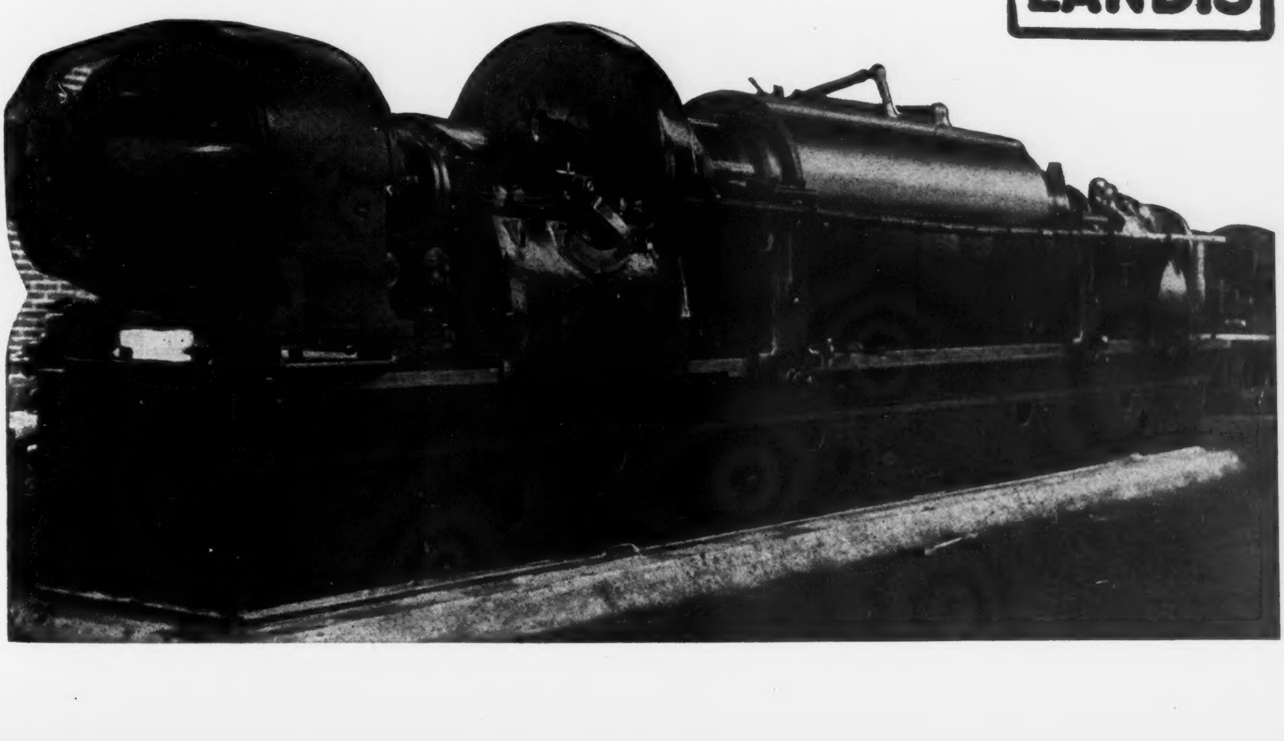
LANDIS TOOL COMPANY, Waynesboro, Pa.

New York Office: 30 Church Street

Chicago Office: 618 Washington Blvd. **Detroit Office: 5928 Second Blvd.**

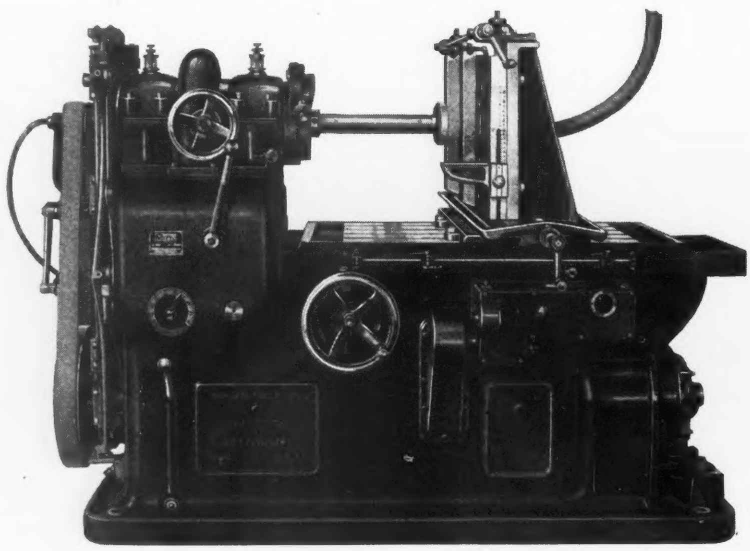
Domestic Agents: Hallidie Machinery Co., Seattle; Smith, Booth, Usher Co., San Francisco and Los Angeles; Peden Iron & Steel Co., Houston; Fulton Supply Co., Atlanta; F. C. Richmond Machinery Co., Salt Lake City; Moore Handley Hardware Co., Birmingham. **Canadian Agents:** F. F. Barber Machinery Co., Toronto; Williams & Wilson, Ltd., Montreal. **Foreign Agents:** R. S. Stokvis & Zonen, Rotterdam; R. S. Stokvis & Fils, Paris; Anderson, Meyer & Co., Ltd., Shanghai; Andrews & George Co., Ltd., Tokyo; Benson Brothers, Sydney and Melbourne; Burton, Griffiths & Co., Ltd., London; Wilh. Sonesson & Co., Malmo and Copenhagen.

LANDIS



Micro

New Grinding Standards for Your Shop



Send us a description of the work you handle and our engineers will submit recommendations for your consideration.

The Micro gives you
Range
Precision
Production—*and*
Ease of Operation
—In Greater Measure

YOU will do well to acquaint yourself with the merits of the Micro Internal Grinder if the efficiency of your equipment or your product is dependent upon Internal Grinding.

The following Micro features insure superior finish and accuracy at a minimum cost of time and labor:

Greater weight, properly distributed; variable head stock speeds that insure correct work travel; pantograph drive mechanism that eliminates vibration and speed deflection; wide range, permitting the grinding of holes from 1¾" to 15" and 16" deep; ability to remove maximum stock in single cut; simple controls and quick set up fixtures for mounting of work.

MICRO MACHINE COMPANY

Factory and General Offices: Bettendorf, Iowa, U. S. A.

Our New Booklet,

"The Plant—The Facilities—The Methods"

follows the sequence of its title admirably.

Our *plant* is pictured on the cover.

Next two pages show some interesting interiors, featuring the exceptional *facilities* of the plant.

Then come ten pages of *methods*—and these are the pages that will hold your interest.

When you've read the booklet, you will have a great respect for the products it illustrates. May we send a copy?

The Oesterlein Machine Co.

Cincinnati, Ohio

OHIO

A Good Diamond

Keeps your wheels right for good grinding.

The best and most economical wheel dressing tool.

FRANCIS Diamond Grinder Tools

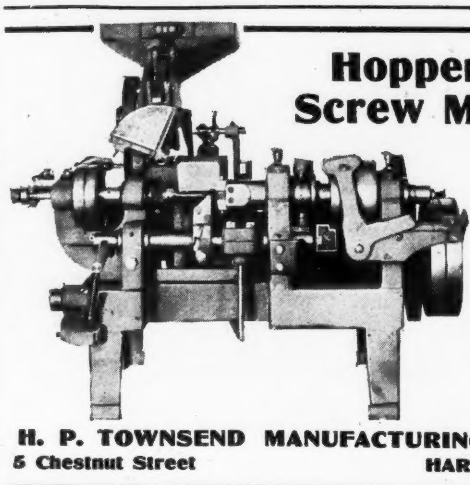
Durable, high quality stones, correctly set. Tools for all types of wheels and grinders. Send for sizes and price list.

FRANCIS & COMPANY

First Nat'l. Bank Bldg. 50 State St., Hartford, Conn.

Est. in 1799 Keep Your Wheels Right for Good Grinding!

Hopper Feed Screw Machines

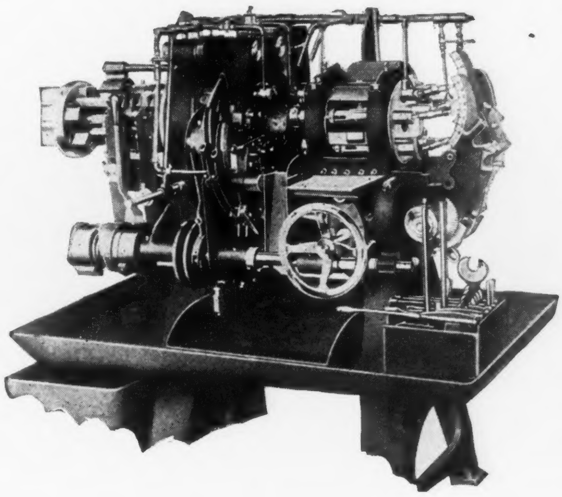


for any Metal Cutting Operation or any Blanks fed from Hopper or Magazine

H. P. TOWNSEND MANUFACTURING COMPANY

5 Chestnut Street HARTFORD, CONN.

Proof of High Speed

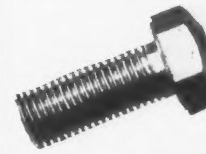


Each of the pieces shown is absolute proof of the ability of the Davenport Automatic to turn out screw machine work at tremendous speeds—and, at the same time, hold to the closest limits of accuracy.

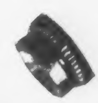
No forcing or crowding with the Davenport—the *five spindles* provide more than enough capacity—work is accurate.

Get Davenport production and get maximum profit.

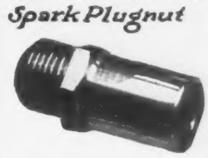
Specimens Actual Size



Steel–9 Seconds
Hex Head Screw



Brass–2 Seconds
Spark Plugnut



Brass–4 Seconds
Grease Cup

DAVENPORT
MACHINE TOOL CO., Inc.
ROCHESTER, N. Y., U. S. A.

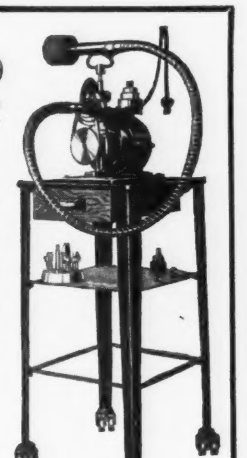
Represented by Motch & Merryweather Machy. Co., Cleveland, Cincinnati, Detroit, Pittsburgh. Henry Prentiss & Co., Inc., New York.

5 DAVENPORT
Spindle Automatic Screw Machine

Established 1905 Originators and Manufacturers

Strand

This type MP5 ¼ H.P. Machine is only one of the many types and sizes we build. Machines from 1/10 to 2 H.P. for use in every branch of the metal industry.



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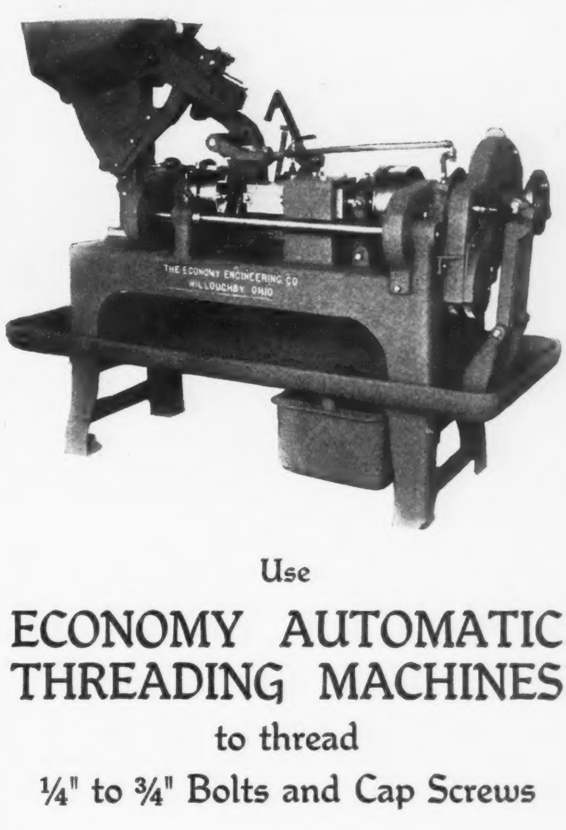
N. A. STRAND & COMPANY
CHICAGO, ILL.
Manufacturers

Main Offices and Factory
5001 No. Lincoln St.

Agencies in all Principal Cities of United States



Use

ECONOMY AUTOMATIC THREADING MACHINES

to thread

¼" to ¾" Bolts and Cap Screws

The Economy Engineering Company
WILLOUGHBY, OHIO

110 Per Hour—*Maintained* Production

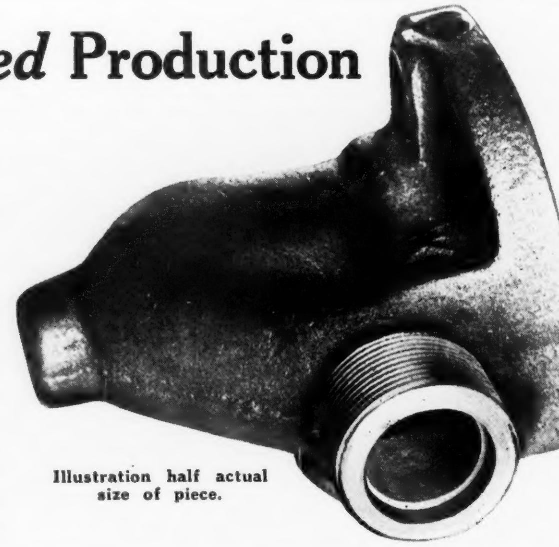
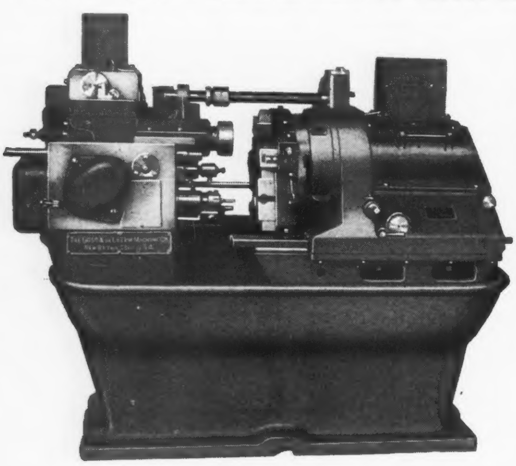


Illustration half actual size of piece.

The Goss & De Leeuw Chucking Machine maintains an exceptionally high production average on work such as the piece shown. This is a check valve case of cast iron with a thread diameter of $1\frac{7}{8}''$, 11 threads per inch. Boring and turning depth is $1\frac{1}{2}''$. Goss & De Leeuw Production is 110 per hour.

This machine is of the multiple spindle type; *cutting tools revolve*—work is held on turret and fed against the tools. It is a small, compact machine—exceptionally efficient in turning, drilling, boring, reaming, facing, threading, oil-grooving (straight or spiral) and light broaching on castings, forgings and second operation work. Send for complete description.

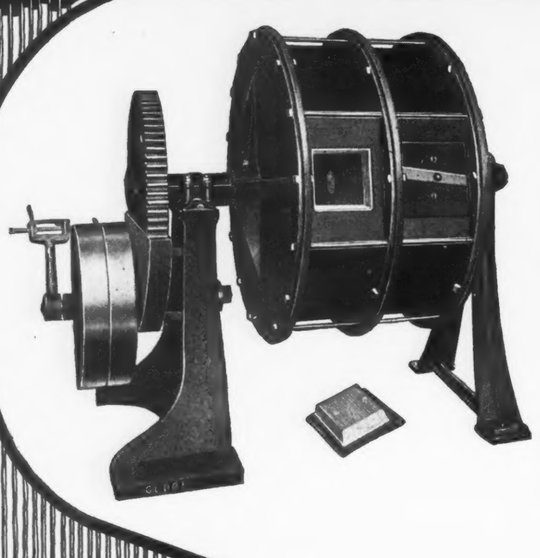


THE GOSS & DE LEEUW MACHINE CO.
NEW BRITAIN, CONN.

Representatives—Henry Prentiss & Company, New York State, Northern New Jersey, Erie, Pa., Connecticut, Massachusetts. John H. Glover, 2120 No. Menard Ave., Chicago, Ill. S. B. Martin, 1899 E. 82nd St., Cleveland, Ohio. Michigan Representative—J. C. Austerberry, 684 E. Congress St., Detroit.

Goss & DE Leeuw Chucking Machine—

GLOBE TUMBLING BARRELS



A Money Making Barrel

SOMEBODY who had replaced expensive hand polishing of small parts with Globe Burnishing Barrels, must have originated the phrase "Barrels of Money."

A two or three compartment barrel gives maximum capacity for the floor space used and handles two or three kinds of work at the same time.

Shells are cast iron with wood linings, last forever and pay handsomely. Write for the facts.

The Globe Machine & Stamping Co.
1255 West 76th St., Cleveland, Ohio

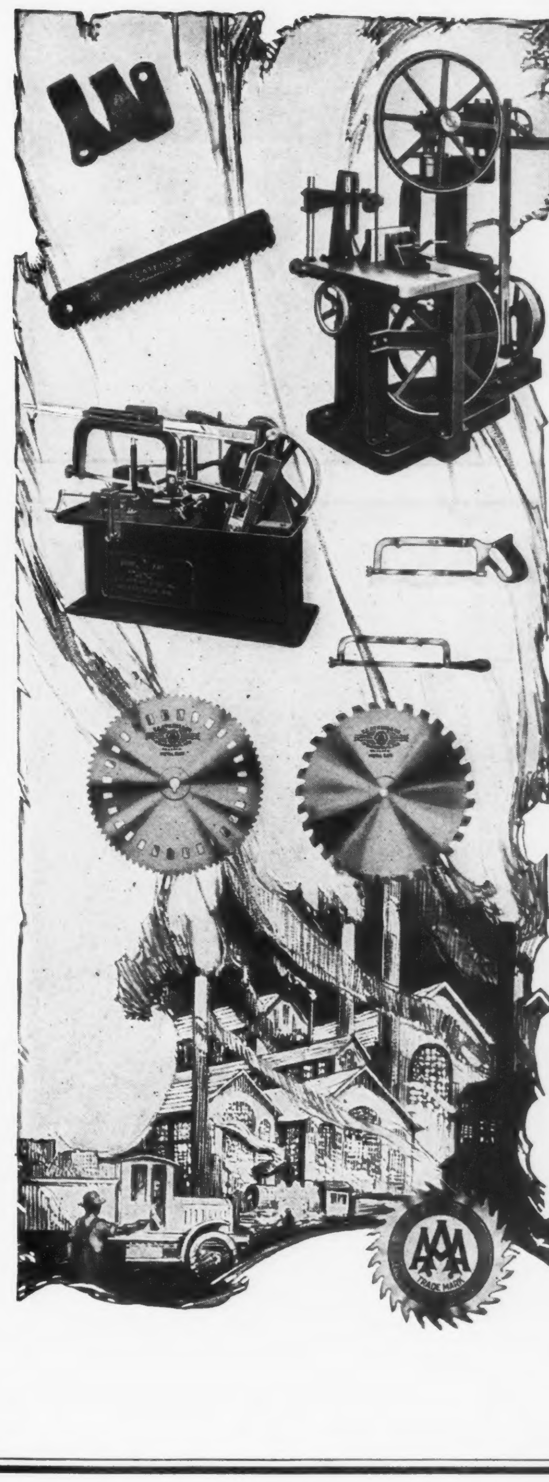
Globules of Wisdom

A wise man is one who knows that a fact is a fact without having to bump his head against it first.

ATKINS

METAL CUTTING SAWS

Increase Production— Save Time, Labor and Money



You can do all these things in your metal cutting operations, in a greater or lesser degree, depending upon how completely your shop or factory is equipped with Atkins Metal Cutting Saws, Hack Saw Blades, for use in frames or machines; Hack Saw Frames and Metal Cutting Machines.

A Perfect Saw for Every Purpose

Without obligation send us your name and address to permit us to place before you interesting data and figures of tests which will prove to you that our products are as our slogan implies,

THE FINEST ON EARTH

Send for "Saws in the Shop," a book of valuable information for master mechanics, foremen, machinists and millwrights.

E. C. ATKINS & CO.

Established 1857 **"The Silver Steel Saw People"**

HOME OFFICE AND FACTORY, INDIANAPOLIS, IND.

Canadian Factory; HAMILTON, ONTARIO. **Machine Knife Factory; LANCASTER, N. Y.**

Branches carrying complete stocks in the following cities:

Atlanta
Chicago
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New York City
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Hack Saws

A Wonder Blade!

VICTOR SAW WORKS, Inc.
MIDDLETOWN, N. Y.

SPECIAL FLEXIBLE BLADE

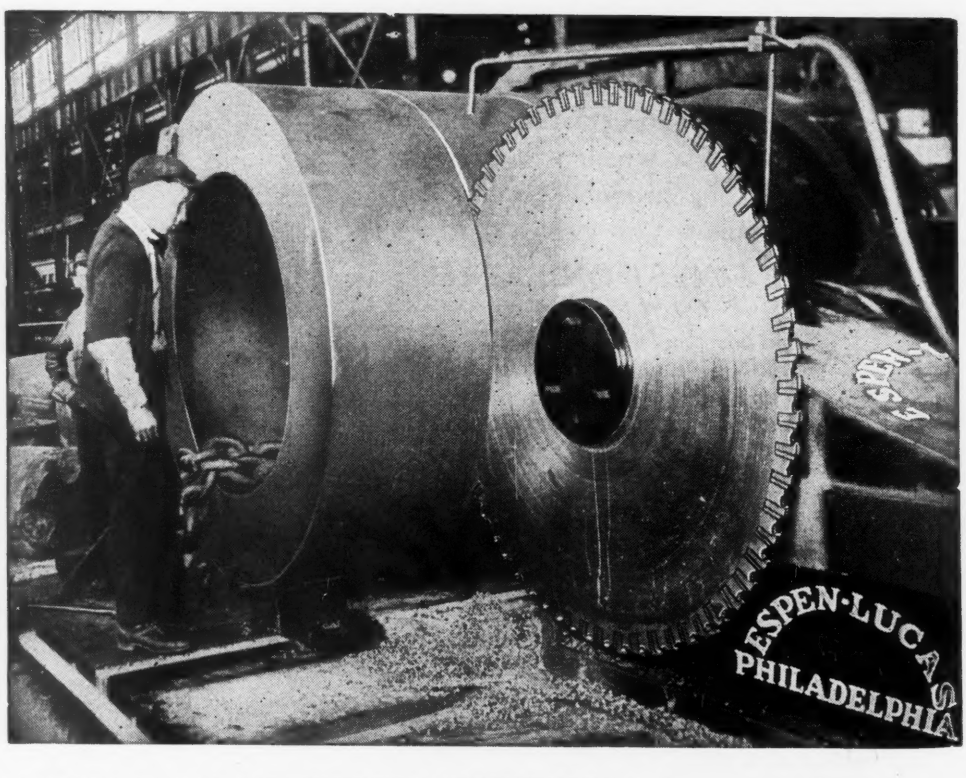
This blade is practically unbreakable and is designed especially for the cutting of sheet steel, galvanized iron, heavy tin sheets and peculiar shapes and sizes of thin materials of soft texture that usually produce breakage.

Our chart for the selection of blades will be mailed to any mechanic giving his name and where employed. Enclose 10c for postage. For further information write for booklet.

FAST AND ECONOMICAL SAWING

Tell us your needs, we have the knowledge, experience and will to correctly advise.

190 types and sizes of Sawing Machines for sawing all kinds of metal.



THE ESPEN-LUCAS MACHINE WORKS, Front and Girard Avenues PHILADELPHIA, PA.

Rhodes—
A Shaper or a Slotter

Where work of complicated contour is to be machined to close limits the Rhodes Shaper-Slotter is an efficient, economical, highly accurate machine. Because work can be machined from practically any angle, in either Shaper or Slotter position of the ram, accuracy can be maintained in successive operations without the waste of time ordinarily required to reset it in correct alignment.

The change from Shaper to Slotter is quickly and easily made; the machine is compact; the saving in space and investment are distinct advantages; accessories, such as the circular shaping attachment, give the machine wide range; many other advantages we'd like to tell you about.

Capacity: Slotter 3½", Shaper 7". Send for catalog M-22.

The Rhodes Manufacturing Co.
Hartford, Conn., U. S. A.

Luma

Write your name on every piece of work—

with the Luma Electric Combination Instrument; mark your tools; do countless jobs of annealing and soldering; demagnetize work that comes from the magnetic chuck by simply passing it across the top of the "Luma."

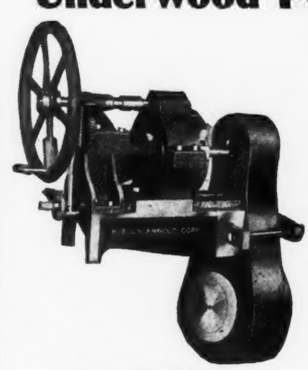
Plug the "Luma" in on any A.C. lighting circuit and turn it to a hundred profitable uses; it's a necessary piece of equipment in every shop.

Simple, practical, self-contained—let us tell you about it.

Luma Electric Equipment Company
P. O. Box No. 132 Main Office, TOLEDO, OHIO

Underwood Portable Tools

For all Purposes



Crank Pin Machine

- Crank Pin Turning Machine
- Boring Bars
- Rotary Planers
- Milling Machines
- Flue Cleaners
- Builders of Special Machinery

Write for Catalog

H. B. UNDERWOOD CORP.
PHILADELPHIA, PA.
Established 1870

WAPPAT for Medium Size Gears

What is your need in medium size gears? Whatever it is, we can furnish you with exactly what you want. Our specialties are medium size spurs and bevels.

We are located in the heart of Pittsburgh's foundry district and have every facility to work with that this location affords.

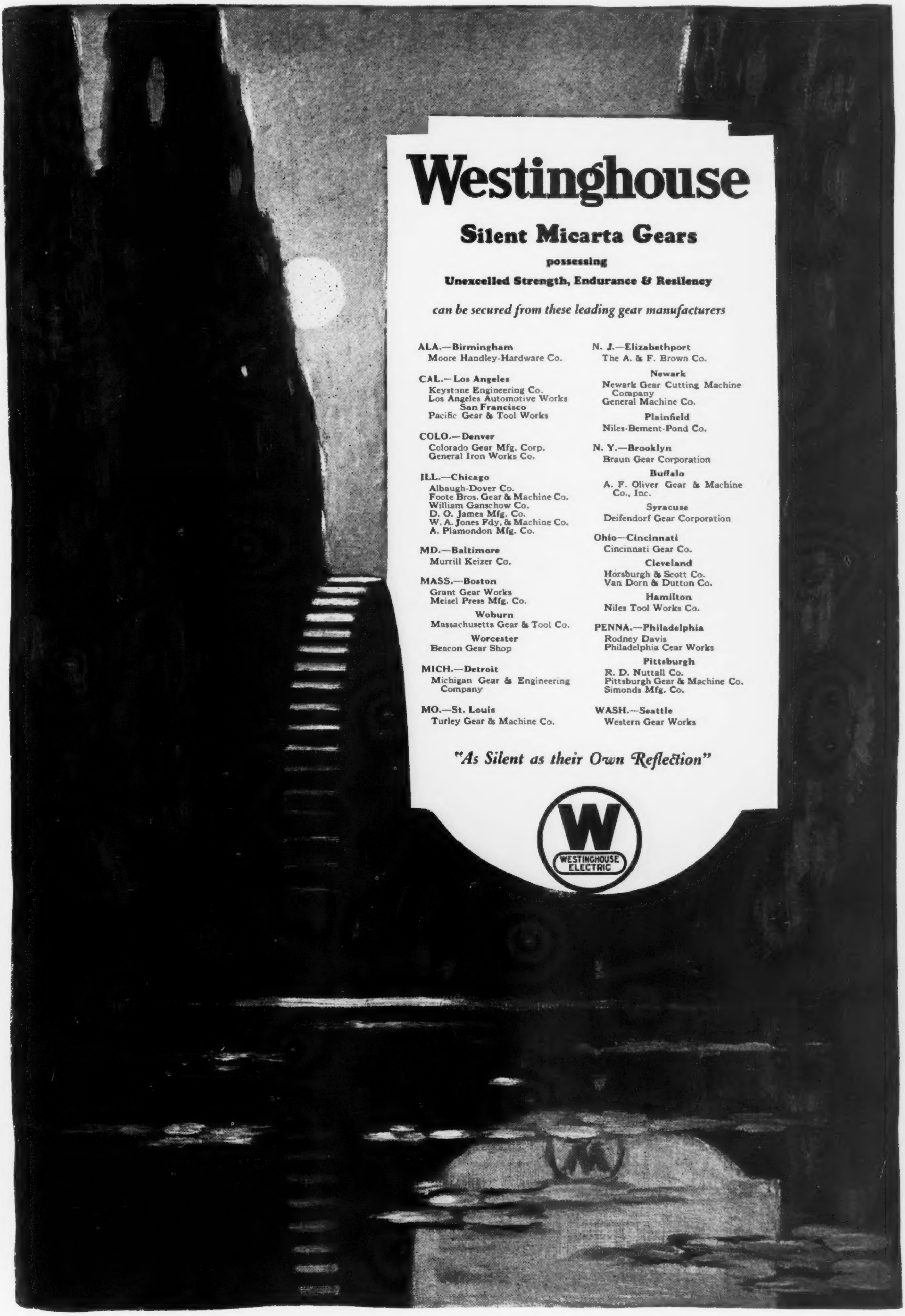
Spur gears up to 30"—bevels up to 24". Small gears down to 20 pitch.

Write for our prices. Quality cannot be exceeded.

Wappat Gear Works
53 N. Braddock Ave.
PITTSBURGH, PA., U. S. A.

MEMBER OF AGMA

Our Specialty—Small Bevel Gears in Quantity


Westinghouse
Silent Micarta Gears
possessing
Unexcelled Strength, Endurance & Resiliency
can be secured from these leading gear manufacturers
ALA.—Birmingham
Moore Handley-Hardware Co.
CAL.—Los Angeles
Keystone Engineering Co.
Los Angeles Automotive Works
San Francisco
Pacific Gear & Tool Works
COLO.—Denver
Colorado Gear Mfg. Corp.
General Iron Works Co.
ILL.—Chicago
Albaugh-Dover Co.
Foote Bros. Gear & Machine Co.
William Ganschow Co.
D. O. James Mfg. Co.
W. A. Jones Fdy. & Machine Co.
A. Plamondon Mfg. Co.
MD.—Baltimore
Murrill Keizer Co.
MASS.—Boston
Grant Gear Works
Meisel Press Mfg. Co.
Woburn
Massachusetts Gear & Tool Co.
Worcester
Beacon Gear Shop
MICH.—Detroit
Michigan Gear & Engineering Company
MO.—St. Louis
Turley Gear & Machine Co.
N. J.—Elizabethport
The A. & F. Brown Co.
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Newark Gear Cutting Machine Company
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Braun Gear Corporation
Buffalo
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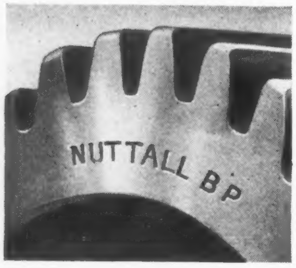
R. D. Nuttall Co.
Pittsburgh Gear & Machine Co.
Simonds Mfg. Co.
WASH.—Seattle
Western Gear Works
"As Silent as their Own Reflection"
W
WESTINGHOUSE ELECTRIC

It's False Economy to Use Common Gears

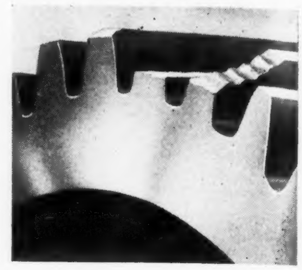


Nuttall rounded teeth—easy to install.

It's true ordinary gears that sell for less—but there is no economy in their use when you figure it on a service basis. Transmission losses, break-downs and replacements are charges against that kind of economy.

Nuttall BP Gears are produced from a superior heat-treated steel, made according to finest manufacturing methods. The result is a product that gives *four times* the life of ordinary cast steel gears.

The wide adoption of Nuttall Gears by all industries speaks volumes for Nuttall quality—and that is the quality you should have.



Ordinary teeth—sharp edges at ends. Apt to chip off.

Philadelphia Office:
Westinghouse Bldg.,
30th and Walnut

R.D.NUTTALL COMPANY
PITTSBURGH PENNSYLVANIA

Chicago Office:
2133 Conway Bldg.

Lyman Tube & Supply Co., Ltd., Montreal, Toronto

Nuttall Gears

The New Garrison Gear Grinder

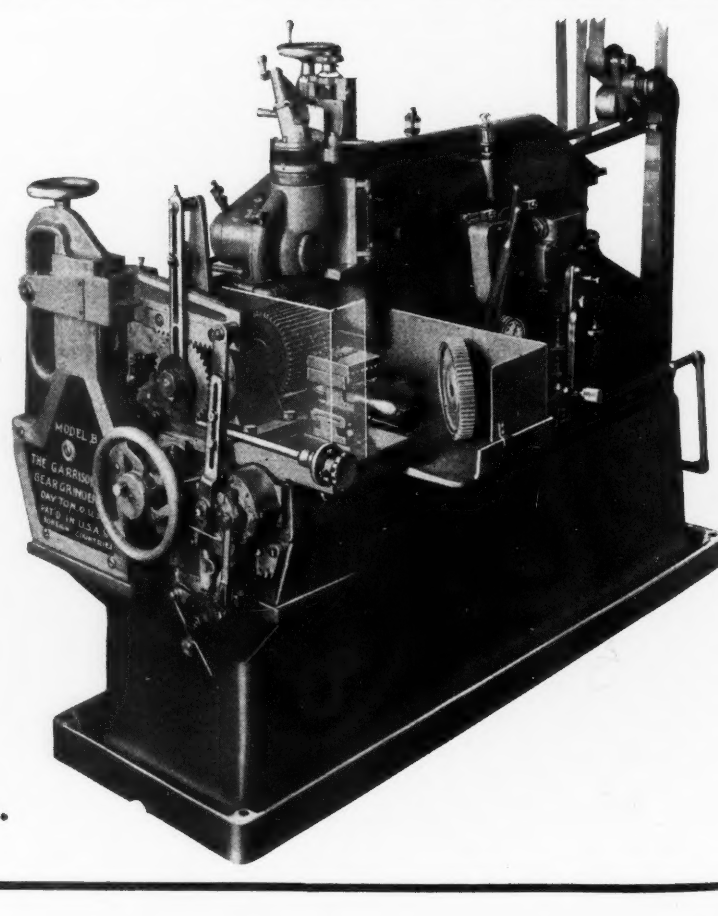
Model B—Hydraulic

It's not how many seconds it takes to finish a tooth that counts. It's how many gears can be accurately finished over a period of a week or month and the average cost per gear.

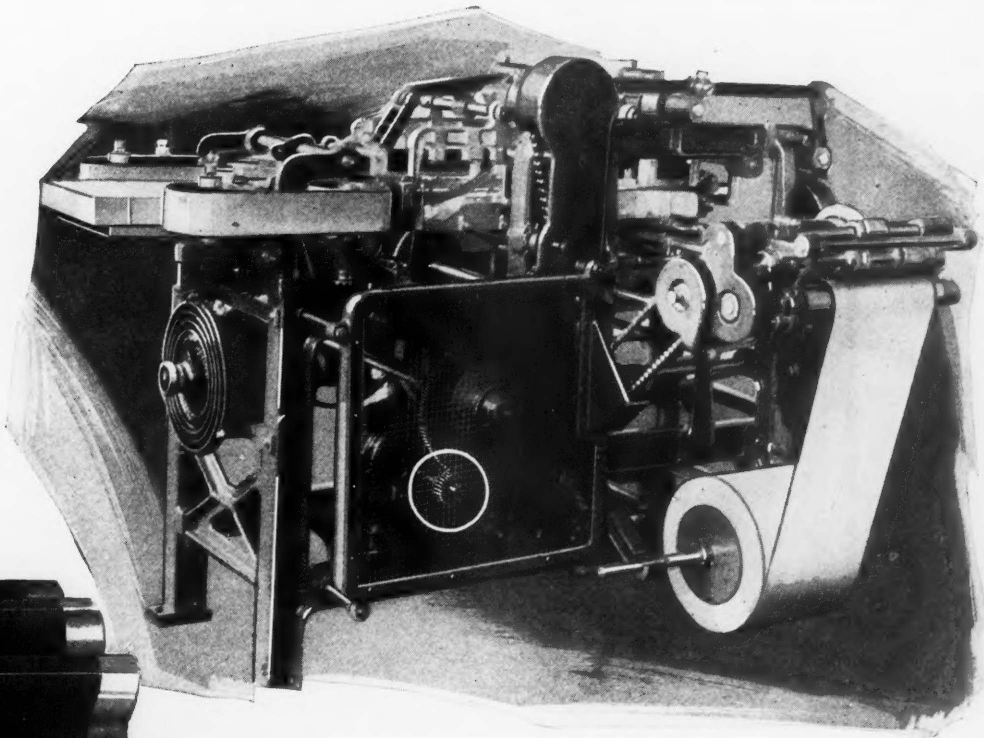
The principle, the method and the construction of Garrison Gear Grinders is different from that of any other grinder, consequently the accuracy, the efficiency and economies obtainable are so different as to excite comment.

The advantages of finishing *both sides* of the teeth of *several gears* to a *predetermined size* with *one wheel* at *one operation* will be appreciated, not only from a standpoint of *economy* but from the *unexcelled accuracy* obtained.

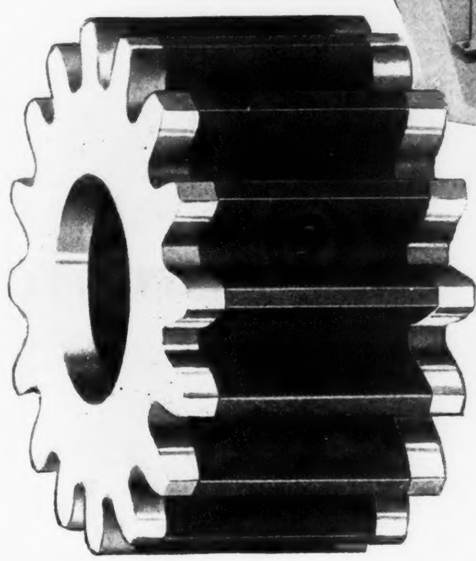
Half as many operators, 50 to 80% less time spent in chucking and indexing, provides just that many more grinding hours per machine per day.

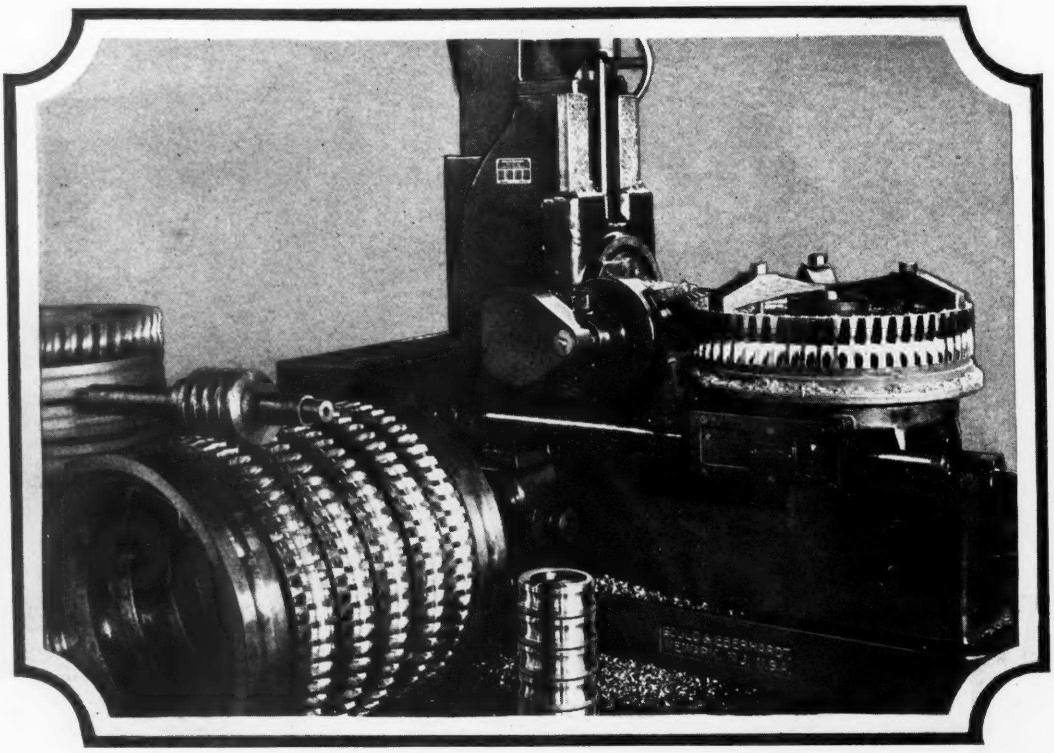


The Garrison Gear Grinder Co.
DAYTON, OHIO



Fabroil Gears installed on Heat-sealing Machine made by Package Machinery Co.





60 T—2 Dia. P—5" Face—Tough Bronze
2 Hours 40 Minutes Each

G & E

HAVE you a Worm Wheel Problem? We can help you solve it. Many worm wheel drives have failed through inadequate knowledge.

It is a deep subject on which our Engineers have had years of experience. Tell us your troubles. We will help you out.

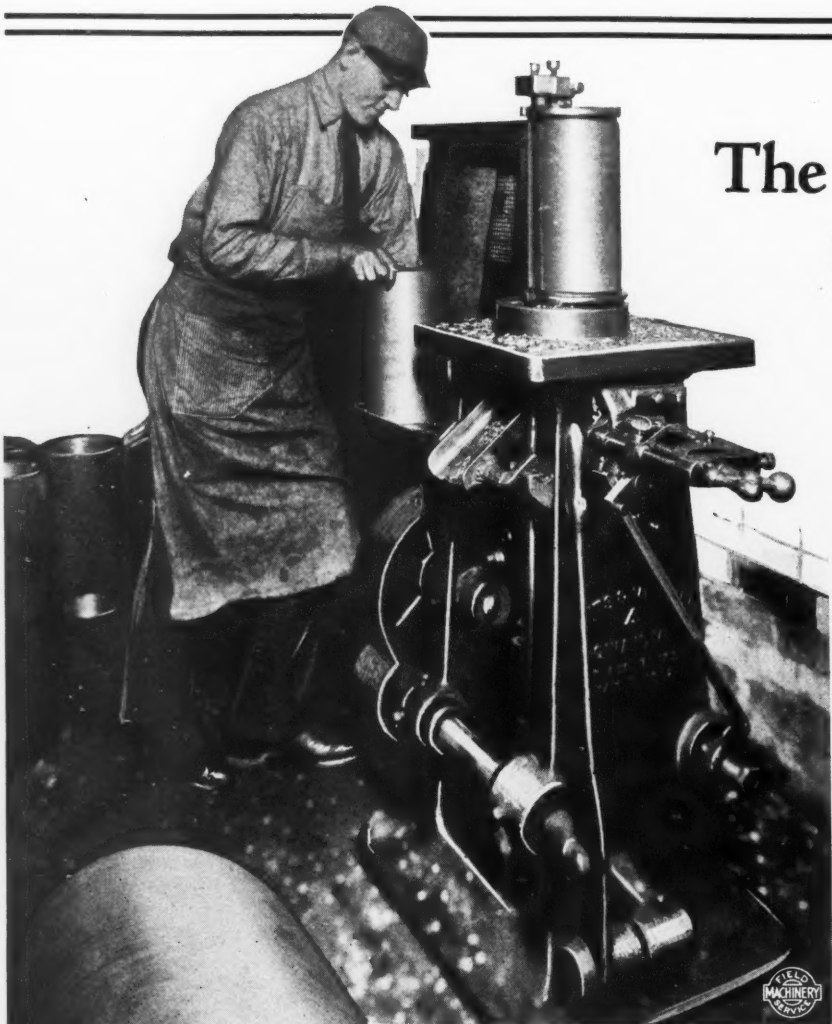
Ask for Bulletin 132

MEMBER OF AGMA

GOULD & EBERHARDT
"HIGH DUTY" SHAPERS
AUTOMATIC GEAR AND RACK CUTTING MACHINERY
ESTABLISHED 1833 NEWARK, N.J. U.S.A. CHANCELLOR AVE.

YOU SEE THEM EVERYWHERE

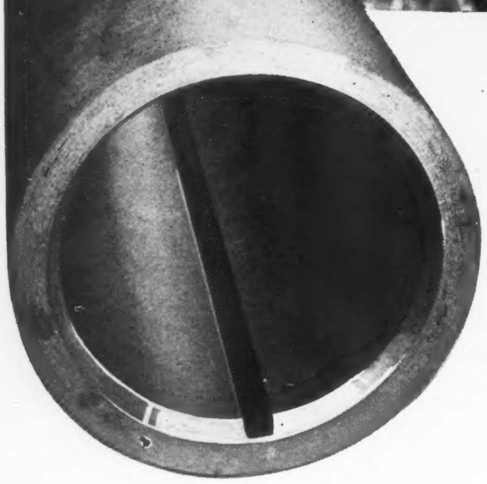
The "GIANT" Keyseater



The Busiest Machine in the Shop

USED as a production machine, for keyseating steel alloy sleeves for paper slitting machines as well as for general keyseating on pulleys, gears, clutch drums, etc., there's plenty of work for the **"GIANT"** Keyseater at the Cameron Machine Company, Brooklyn, N. Y.

The operation shown is cutting keyways 13/32" wide by 5/32" deep in steel sleeves 11" long by 6¼" diameter. Six per hour is regular production on sleeves this size. The **"GIANT"** Keyseater is as well adapted for use as a production machine as for general work. Design and construction that make it easy to set up and remove work; stroke that can be set to repeat the same cut as often as desired or is easily reset for new work; accuracy that is insured by sturdy construction and correct balance—are valuable in any application.



If you cut keyways or slots in anything, any quantity, examine a **"GIANT"** Keyseater. Eight sizes —send for details.

MITTS & MERRILL, 843 Water St., SAGINAW, MICH.

FOREIGN AGENTS: Burton, Griffiths & Co., London, England. Aux Forges de Vulcain, Lyons and Paris, France. V. Lowener, Oslo, Norway, and Stockholm, Sweden.

"—and bring the 'Forbes' up to the job"

There was a leak in an old supply pipe—it looked as though repairs would close the plant for several days at least. But the FORBES PIPE CUTTING and THREADING MACHINE in the engine room saved the day.

Instead of dismantling the plumbing system to repair the pipe, the Forbes is taken to the scene of trouble, the pipe cut off beyond the leak and rethreaded. A new joint and a new length of pipe is then only a matter of minutes and work is resumed with minimum loss of time.

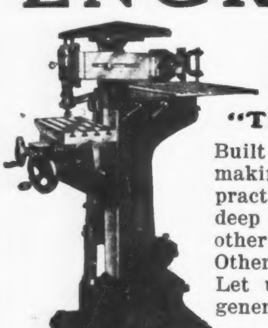
All FORBES PIPE CUTTING and Threading Machines are self-contained; all—even the larger sizes—may be set up for use anywhere; all sizes may be hand operated. The operating method, by which the work enters the machine from the rear and is held stationary in a self-centering vise while the dies revolve around, it makes it possible to thread pipe in position and to thread long lengths and wide angles.

Forbes capacity, convenience and service, pay on all classes of pipe work. Sizes to take 1/4" to 16" pipe. Send for details.

The Curtis & Curtis Company

324 Garden Street BRIDGEPORT, CONN., U. S. A.

ENGRAVING



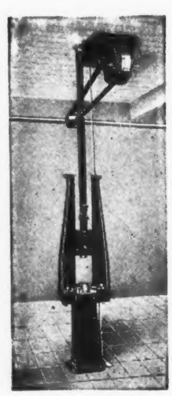
The DECKEL No. 2 Engraving Machine

"That Does the Work"

Built for the Die, Mold and Stamp-making Industries. It has all the practical features essential for deep engraving on steel, brass or other material.
Other types and sizes.
Let us solve your die, mold, and general engraving problem.

H. P. Preis & Co., Inc.

9-13 Campbell St., NEWARK, N. J.



"PECK"

Automatic Drop Lifters

will convert those hand or foot drops and unsatisfactory automatics into

PRODUCTIVE AUTOMATIC DROPS

Capacity 15 to 5000 pounds

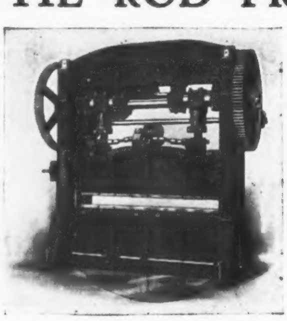
DROP PRESSES for all purposes

MINER & PECK MFG. CO.

DERBY, CONN.

NEW L & N

TIE ROD PRESS-BRAKES



A combination of the better features of all existing types. Practically accident proof. Deflection minimum.

Write us

LOY & NAWRATH DIV., BIRMINGHAM IRON FOUNDRY

DERBY, CONNECTICUT

Hurlbut, Rogers Cutting-off Machines

Have patented features found in no other machines; speeds and feeds to suit all metals. Capacity to 10" stock.

Write for catalog

THE HURLBUT, ROGERS MACHINERY CO.
Nashua, N. H.

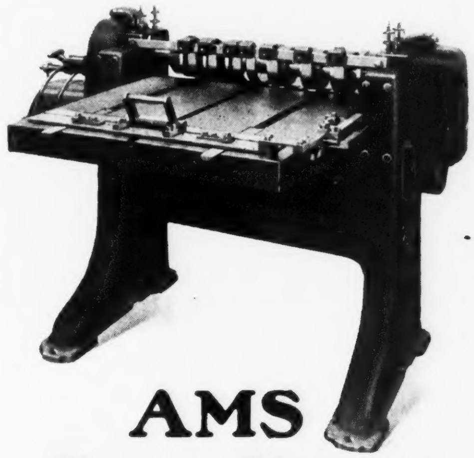
"LAPOINTE OF HUDSON"

BROACHING MACHINES AND BROACHES

Equipment and Service that insure PROFITABLE broaching on all classes of work.

Write for details.

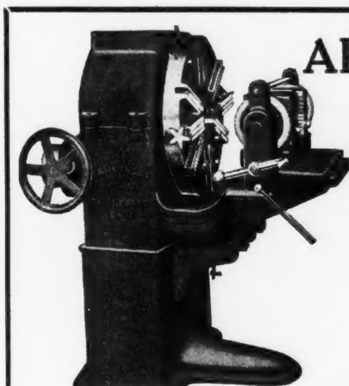
THE LAPOINTE MACHINE TOOL COMPANY, Hudson, Mass., U. S. A.



AMS
Gang Slitters
for All Light Sheet Metals

High Speed—Labor Saving. Will trim or slit Dead True. Automatic or hand feed. Double edged cutters give double service and can be ground without removing from machine. AMS Quick Adjustable Hub Clamp and many other exclusive features make it the most satisfactory machine of its kind. Write for catalog and complete details.

The Max Ams Machine Co.
101 Park Avenue, New York
Branches: Chicago, Ill., and London, Eng.



ARMSTRONG No. 3 Pipe Threading Machine

POWER ONLY

Threads Pipe 1 inch to 6 inches right or left.

MANUFACTURED BY

THE ARMSTRONG MFG. COMPANY
BRIDGEPORT, CONN. ***Only***

MERRELL
Pipe Threading and Cutting Machinery

Hand or Power Operated

THE MERRELL MFG. COMPANY
15 Curtis Street **TOLEDO, OHIO**

The Principle of Force

As exemplified in hand power is so gathered and arranged in the construction of our line of

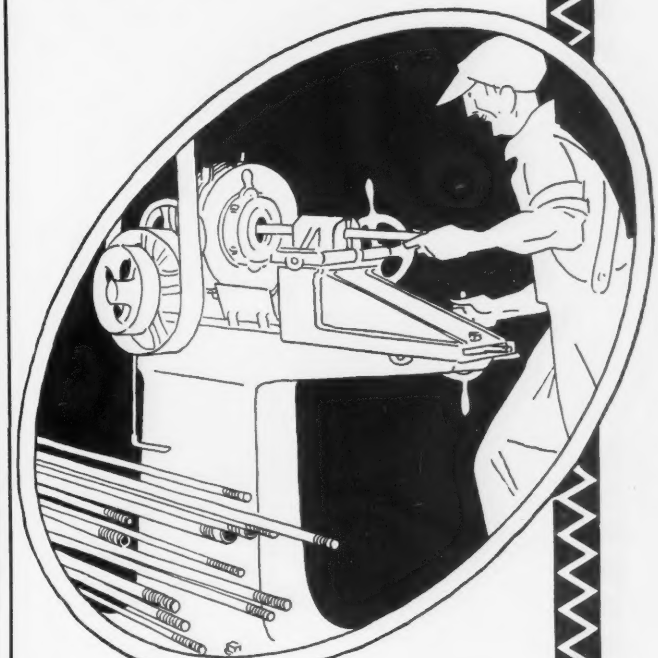
HERCULES SHEARS and ROD CUTTERS

PLAIN OR COMBINATION

that with minimum of effort you obtain maximum of strength.

Nos. 1, 2 and 5 **W. M. & C. F. TUCKER, Hartford, Conn.** Nos. 3 and 4

A Single OSTER PIPE MACHINE Covers All Threading Requirements



PIPE, nipples, casing and bolts threaded on the same Oster combination pipe machine at a decided saving in time and labor.

Pieces long or short—straight or bent—over or under size—handled without complicated change of equipment.

Sturdily built for long, hard service with open type vise, front-cutting die-head, fountain-flood oiling system and automatic die-release.

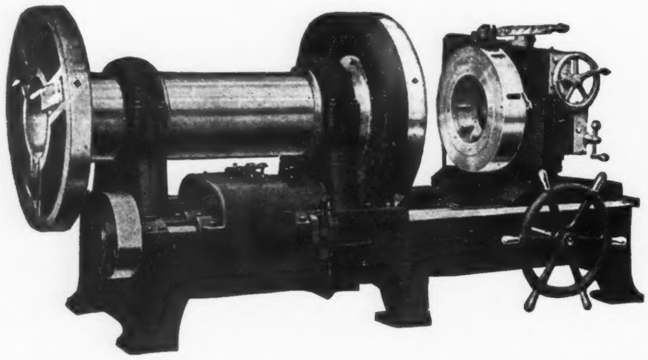
If your supply house cannot supply you, write for a copy of catalog No. 34B, describing the complete line of Oster hand and power pipe threading equipment.

OSTER

The Oster Manufacturing Company

Manufacturers of the most complete line of pipe threading equipment in the world.

2072 E. 61st Place, Cleveland, O.



Friction Is Costly

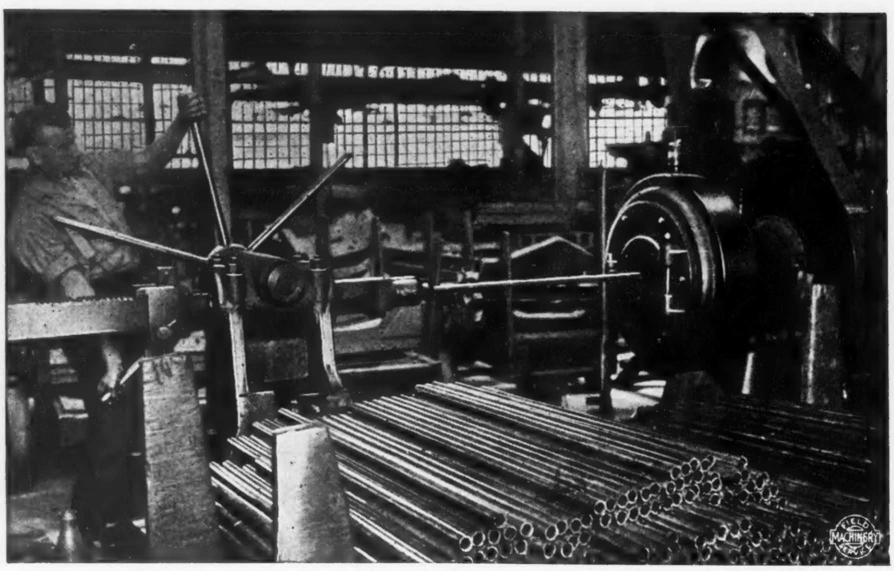
ALL B & K Pipe Threading Machines are regularly equipped with Peerless Dies, which have the CURVED ECCENTRIC RELIEF, gauged to a fine degree of accuracy.

This method of relieving dies allows the cutting edge to stand well ahead of the center line of the pipe and reduces friction to the minimum.

Peerless Dies will give more perfect threads per hour with less power than any other type of die.

Seldom Equaled—Never Excelled—Details on request.

Bignall & Keeler Machine Works, of the N. O. Nelson Mfg. Co.
EDWARDSVILLE, ILLINOIS



Rushing Production *with* Etna Swagers

Let us tell you about swaging—as Etna does it

FOUR Etna Swagers set the production pace in the plant of the A. O. Smith Company at Milwaukee, where steel tubing for automobile chassis tie rods must be swaged to uniform size.

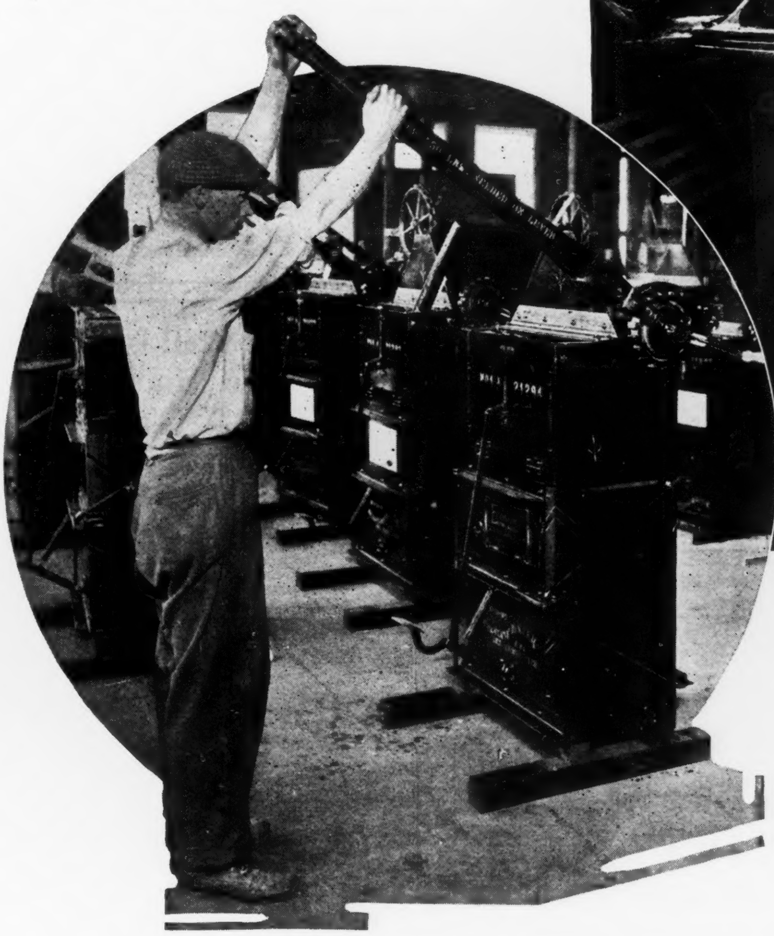
The operator forces the tubing into the rotating dies of an Etna with a capstan wheel. Production is 200 $1\frac{1}{8}''$ tubes per machine per hour—more than enough to keep the rest of the plant continuously supplied with material.

THE ETNA MACHINE COMPANY, Maplewood Ave. and Castle Blvd. TOLEDO, OHIO

Baling Presses—Assembled on a
High Speed Riveting Hammer

The Economy Baler Company, Ann Arbor, Mich., makes a line of sturdy hand and power baling presses, held together almost entirely by rivets, which are hammered into place by a High Speed Riveting Hammer.

About seventy-eight 5/16″ rivets are used in assembling the hand press shown below. In the picture at the right, the camera caught the High Speed Hammer when it was riveting one of four angle irons to the back door of a press. Since 1917 the High Speed Hammer has been used on this work—and always results have been quick, economical and certain.



The High Speed Riveting Hammer is "The Hammer with the Human Stroke." It preserves the principle of the old method of working cold metal, applies power to attain speed, and delivers thousands of blows per minute, just like those of the master metal-worker, wielding with strong arm his hickory helve hammer.

Control is perfect. Blows may be as sensitive or as heavy as desired. The peen rotates as the blows strike, giving the rivet head a finished surface. Rivets may be headed tight or loose—even headed where they are not supported in the center—without swelling or bending the shank.

Let us rivet samples of your work and give you production estimate. Write for Catalog "C"

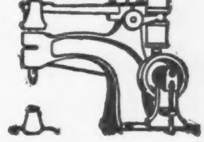
THE PRINCIPLE IS RIGHT

THE HIGH SPEED HAMMER COMPANY, Inc.

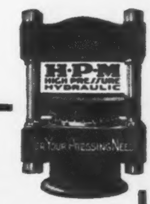
ROCHESTER NEW YORK

FOREIGN AGENCIES: Burton, Griffiths & Co., Ltd., London, E. C., for the British Isles. Aktiebolaget Rylander & Asplund, Stockholm, Sweden, for Sweden and Finland. China, Japan and South America Trading Company, Ltd., Yokohama, Kobe and Osaka, Japan, for Japan and Dependencies.

THE HAMMER WITH THE HUMAN STROKE



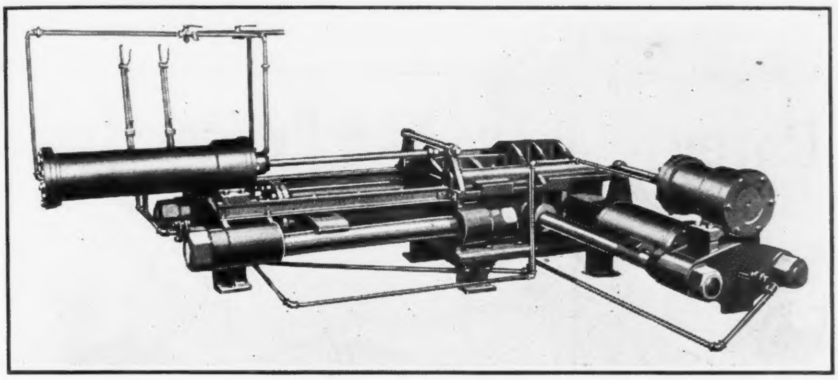
H-P-M HIGH PRESSURE HYDRAULIC PRESSES



"FOR YOUR PRESSING NEEDS"

The H-P-M Scrap Metal Baling Press

THIS press is highly profitable in sheet metal mills and stamping plants for reducing scrap and trimmings to compact form for convenient and economical handling. In this press the cylinders are the moving elements; these back into the baling box, thus keeping the polished ram surfaces and cylinder packings as far away from the box as possible and insuring them against scoring from scrap particles.



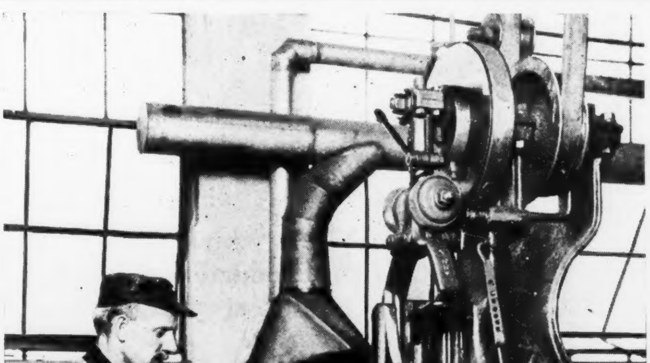
Presses for
Assembling, Die-sinking
(Making and Breaking Force Bits)
Forging
Forming
Bending
Flanging
Broaching, Straightening

Complete details on request

THE HYDRAULIC PRESS MFG. CO.

48 Lincoln Avenue, MOUNT GILEAD, OHIO

NEW YORK CLEVELAND PITTSBURGH CHICAGO



The Ideal Bradley for the Crowded Shop

If you must conserve space install a Bradley Compact Type Hammer. It's light, sturdy, runs at high speed, saves valuable floor space, costs little to buy.

The operator has positive control of the hammer blow at every stage of the forging's progress. All operating shocks are absorbed in the extra heavy anvil block, and work beyond the rated capacity can be handled without endangering the machine.

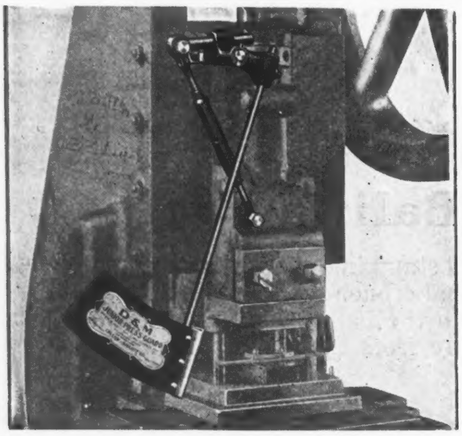
Send for a description of Bradley Cushioned Helve Hammers, Upright Strap Hammers and Upright Helve Hammers.

Equipped for Belt or Motor Drive

C. C. BRADLEY & SON, Inc.

ESTABLISHED 1832

432 North Franklin St. Syracuse, N. Y.



The Press Room Takes the Safety Prize

In a big modern plant the "safety" competition brought a special prize to the department reporting "no accidents" for a month. The press room had no hope—until—the safety engineer ordered D & M Junior Press Guards for each power press. With the hazards removed there hasn't been a press accident since. The press room gets the "safety" prize—while the boss gets better production because the operators can speed their motions without danger.

Inexpensive safety insurance—for all presses.
Thirty days free trial. Send for details.
Give name, size and stroke of press.

TAYLOR-SHANTZ COMPANY
485 St. Paul Street, ROCHESTER, N. Y.

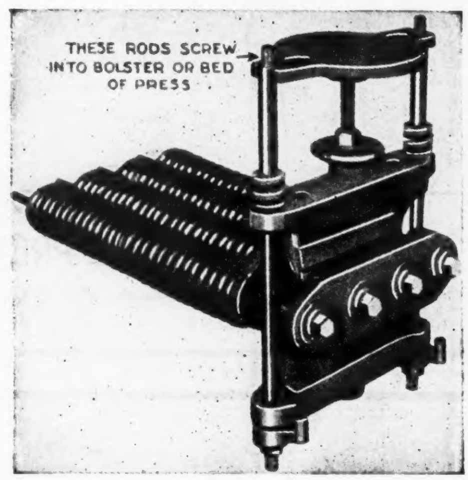
The ATLAS Patent Leverage Device

This feature of the Atlas Arbor Press enables the operator to exert pressure to 15 tons on our No. 4 Machine; simple or compound leverage is instantly available.

Atlas Arbor Presses are built in all sizes and types for work requiring pressure to 40 tons; centering capacity to 38 inches. You'll find them in the best machine shops, auto plants, garage shops and factories—all round usefulness and efficiency makes them profitable everywhere. Send for details.

ATLAS PRESS COMPANY
Kalamazoo, Mich., U. S. A.

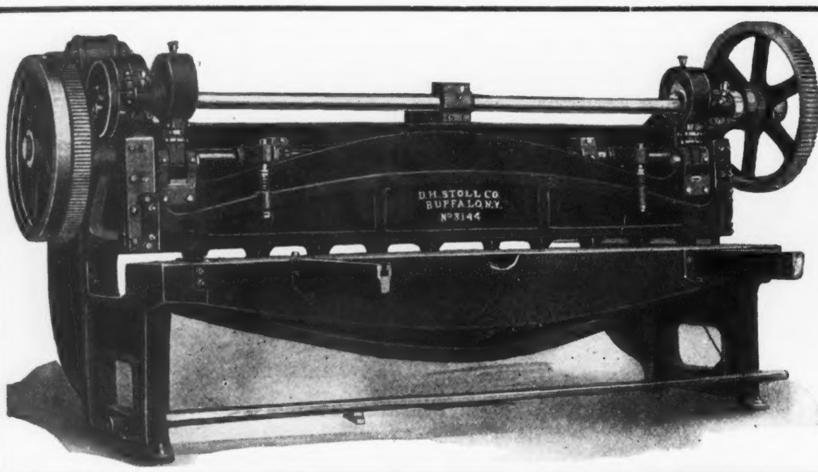
The King Pressure Toggle



A Permanent Attachment that equips a Single Action Press to produce Toggle Press jobs.

More Uniform Work with a Saving of 25% to 60% in Production Cost and 40% to 60% in First Cost of Equipment.

R. D. KING Chicago, Ill.
1620 Monadnock Block

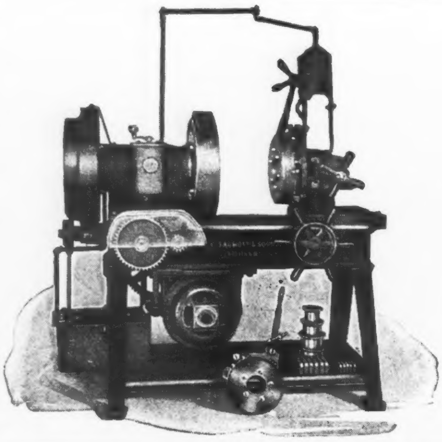


Stoll Shears

Plenty of material is scientifically distributed in Stoll Shears. You can always depend upon them for long uninterrupted service. They are substantial, reliable, speedy and accurate—trouble-proof and profit-sure.

Ask for description of our line of Presses, Shears, Dies and Special Sheet Metal Working Machinery.

The D. H. Stoll Co, Inc.
Buffalo, N. Y.



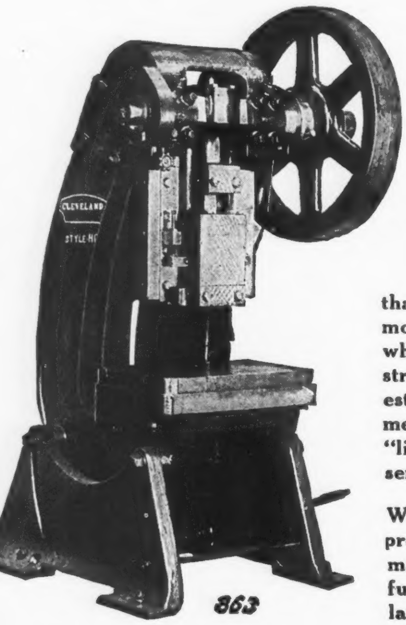
Saunders' Pipe Threading and Cutting Machines

This new type 4-B Improved Pipe Threading and Cutting Machine, motor driven, for threading and cutting pipe from ½″ to 4″ inclusive, is a compact, durable machine, for installation in pipe shops and also for use as a portable machine.

Motor, Belt, or Hand Power Pipe Threading and Cutting Machines to meet all requirements for pipe from ¼″ to 18″ inclusive. Catalog P on request.

D. Saunders' Sons, Inc., Yonkers, N. Y.

CLEVELAND PRESSES



Presses Look Alike

But there's a difference in Clevelands—you'll find that they have more metal where the stress is greatest and that means longer "life" in your service.

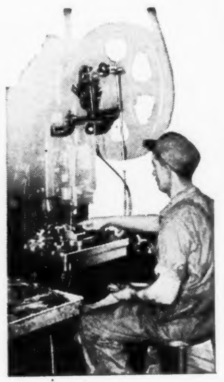
Whatever your press requirements may be we can furnish a Cleveland to meet them.

Yes, sir, you can do it
ON A CLEVELAND

The CLEVELAND PUNCH & SHEAR WORKS CO.
Main Office & Works CLEVELAND, OHIO
PITTSBURGH – CHICAGO – PHILADELPHIA – NEW YORK

The Wiesman Safety Guard

sweeps entire length of bolster plate on half of downward stroke of punch.

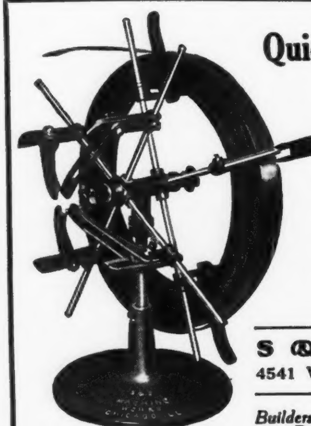


This means that *both* hands of the operator are protected. The workman can concentrate on his job without fear of smashing his hands if the press repeats. Therefore, he does more and better work, which shows in increased profits for you.

Send in for particulars about our 30-day free trial offer.

Wiesman Mfg. Co.
31 to 35 So. St. Clair St.
Dayton, Ohio

Quick S&S Loading

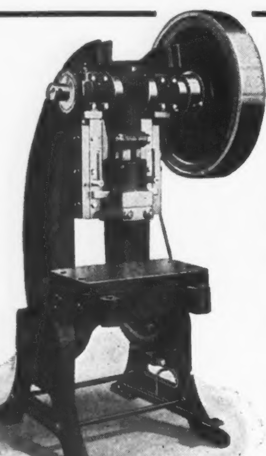


Patent Pending

DOUBLE SWIVEL REELS for use with roll feeds, etc.
SINGLE INCLINABLE REELS for hand feeding.
HORIZONTAL REELS for round wire.
DISC REELS for brass, copper, etc.

S & S Machine Works
4541 W. Lake Street, CHICAGO, ILL.

Builders of Precision Automatic Feeds for Punch Presses and Metal Working Machinery.



A Positive Safety device for L. J. Presses

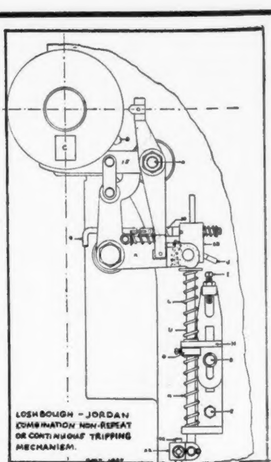
The L. J. Non-Repeat Tripping Device will eliminate 50% to 75% of all press accidents, reducing compensation insurance proportionately.

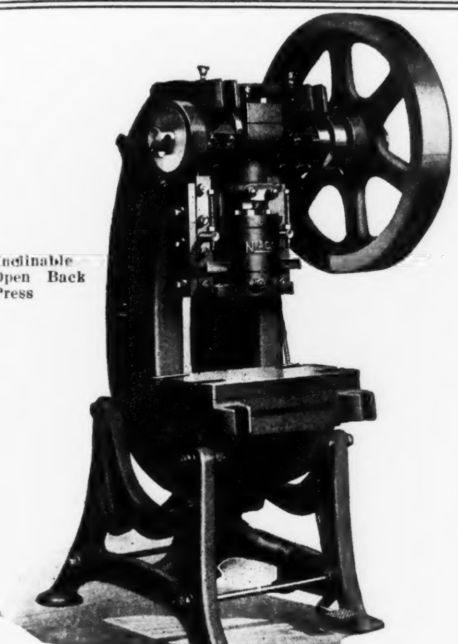
Loshbough-Jordan Presses are high grade machines, backed by a real guarantee, good for one year, that Shaft or Frame cannot be broken while press is operated within rated speeds.

Let us send details on both Presses and Accessory Mechanisms

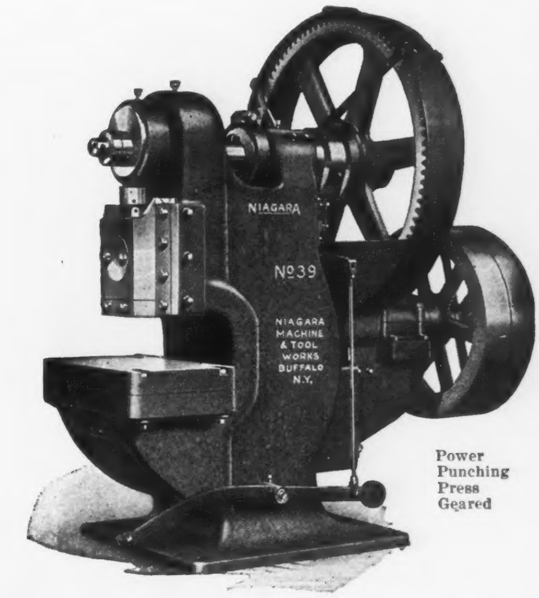
Loshbough - Jordan Tool & Machine Co.
ELKHART, INDIANA

Dealers: Herberts Machinery & Supply Co., San Francisco and Los Angeles, Cal. Northern Machinery Co., Minneapolis. Brown Machinery Co., St. Louis. English Tool & Supply Co., Kansas City, Mo. Stocker-Rumely-Wachs Co., Chicago. Riverside Machinery Depot, Detroit. Cleveland Duplex Mchy. Co., Cleveland, O. M. D. Larkin Supply Co., Dayton, O. Joseph Beal & Co., Boston, Mass. J. L. Lucas & Son, Inc., Bridgeport, Conn. Triplex Machine Tool Co., New York City. Joseph Hyman & Sons, Philadelphia, Pa.





Inclinable Open Back Press



Power Punching Press Geared

NIAGARA

POWER PRESSES

By replacing your equipment with up-to-date Niagara sheet metal working machinery you assure yourself of better and faster production, with a decreased labor cost.

Send for the bulletins that interest you.

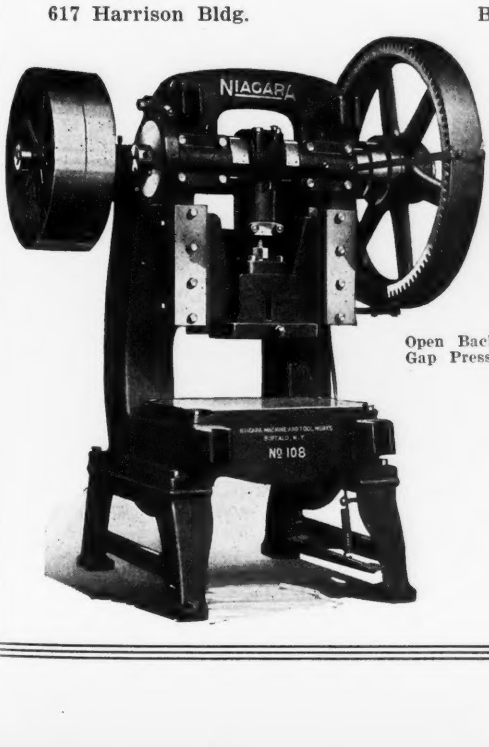
No. 58—Inclinable Presses, Open Back.
No. 59—Power Bench Press.
No. 60—Horn Presses, Side Seamers.
No. 61—Punching Presses.
No. 62—Arch Presses.
No. 63—Straight Sided Presses, Single Crank.
No. 64—Double Crank Presses, Built-up Frame.
No. 65—Double Crank Presses, One-piece Frame.
No. 66—Toggle and Cam Presses.
No. 67—Power Punches, Single, Multiple, etc.
No. 68—Foot Operated Presses.
No. 70—Power Circle Shears, Ring Shears, and Flangers.
No. 71—Power Squaring Shears (Light).
No. 72—Power Squaring Shears (Medium).
No. 73—Power Squaring Shears (Heavy).

Our smaller machines and tools for the sheet metal shop are described in Catalog No. 56.

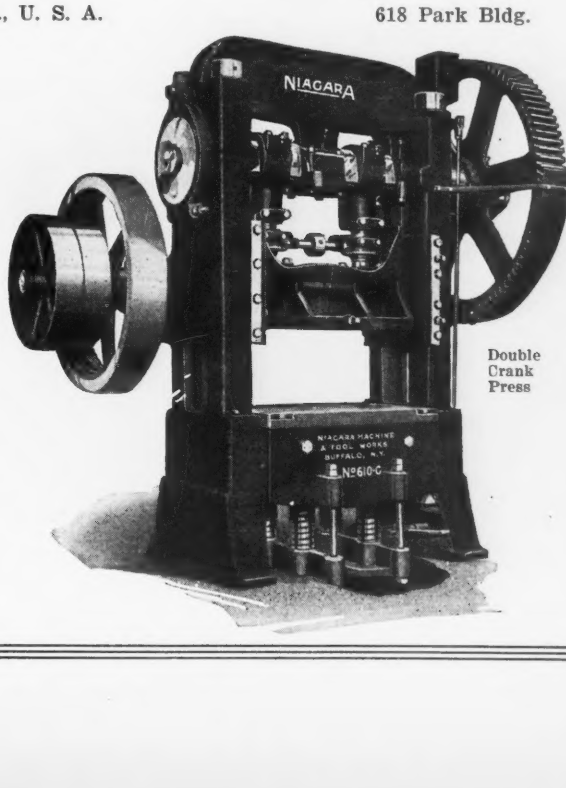
NIAGARA MACHINE & TOOL WORKS
Established 1879
BUFFALO, N. Y., U. S. A.

Philadelphia Office
617 Harrison Bldg.

Pittsburgh Office
618 Park Bldg.



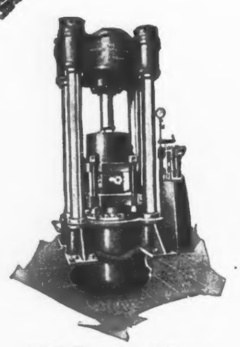
Open Back Gap Press



Double Crank Press

HYDRAULIC EQUIPMENT

For Special Purposes

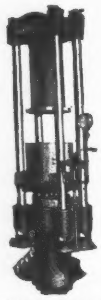


2100 Ton Lead Press
for covering cable and vulcanizing rubber hose.

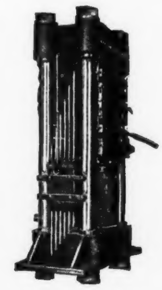
We build complete hydraulic plants including pipe, valves, pumps, accumulators, intensifiers, and presses for every purpose such as:

Forming
Dehydrating
Thermo Plastic Moulding
Blocking and Extruding
Briquetting
Baling
Clay Forming
Sagger Moulding
Moulding and Vulcanizing
Oil Extracting
Cocoa Butter Extracting
Compressing and Forming, Etc.

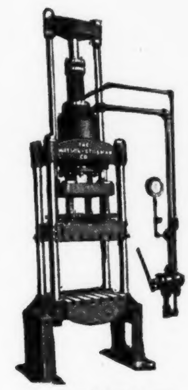
Write for Bulletins.



Curb Press
for Reclaiming Liquid Products.



Multiple Plate Heating Press



Plastic Moulding Press
for Bakelite Redmanol condensite, etc.

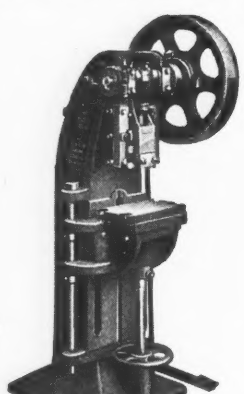
The Watson-Stillman Co.
192 Fulton St. New York City

Chicago, McCormick Building
Philadelphia, Widener Bldg.
Cleveland, Leader-News Bldg.

THE "TOLEDO"

PRESSES FOR EVERY PURPOSE!

Production on General Sheet Metal Work



The favorite "Toledo" Press for pieced tin, stamped ware and general sheet metal work. Designed so that special bolsters, horns, forces, etc., may be easily attached for special work.

Ten sizes, this style, 1000 to 13,000 pounds. Shown with the rest of the line in the "Toledo" Catalog.

The Toledo Machine and Tool Company
TOLEDO, OHIO
Chicago Office: 549 West Washington Blvd.
Detroit Office: Room 3-250, General Motors Bldg.
Engineers, Founders and Machinists on Equipment for Sheet Metal Products

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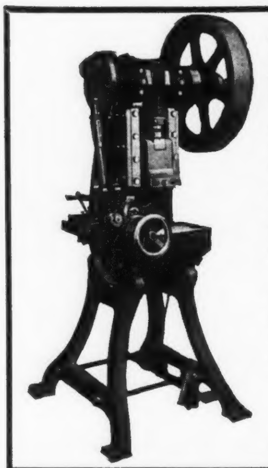

The Pace That Fingers Can't Follow

On presses that aren't being run at full speed because human fingers can't work fast enough to feed them, install a Littell Feeding Device.

There's a Littell Feeding Device that will feed as fast as the press will work —at the pace human fingers can't follow.

Let us explain the application of our Roll, Dial, Drum, Chute and Slide Feeds, Assembling Devices and Straightening and Cutting-off Machines.

F. J. Littell Machine Co.
Dept. M
4125-27 Ravenswood Ave., CHICAGO

CHAMBERSBURG

Steam, Steam Drop and Board Drop Hammers
Trimming Presses Punches and Shears
Hydraulic Machinery of all types and sizes, including Presses, Riveters, Pumps, Accumulators and Special Machinery
CHAMBERSBURG ENGINEERING CO., Chambersburg, Pa.

PRESSES—Foot and Power.
WIRE FORMING MACHINES—Standard or Special.
TUMBLERS—All kinds.
BALL BURNISHING EQUIPMENT.
AUTOMATIC CHUCKING MACHINES.

BAIRD MACHINE CO.
BRIDGEPORT, CONN.

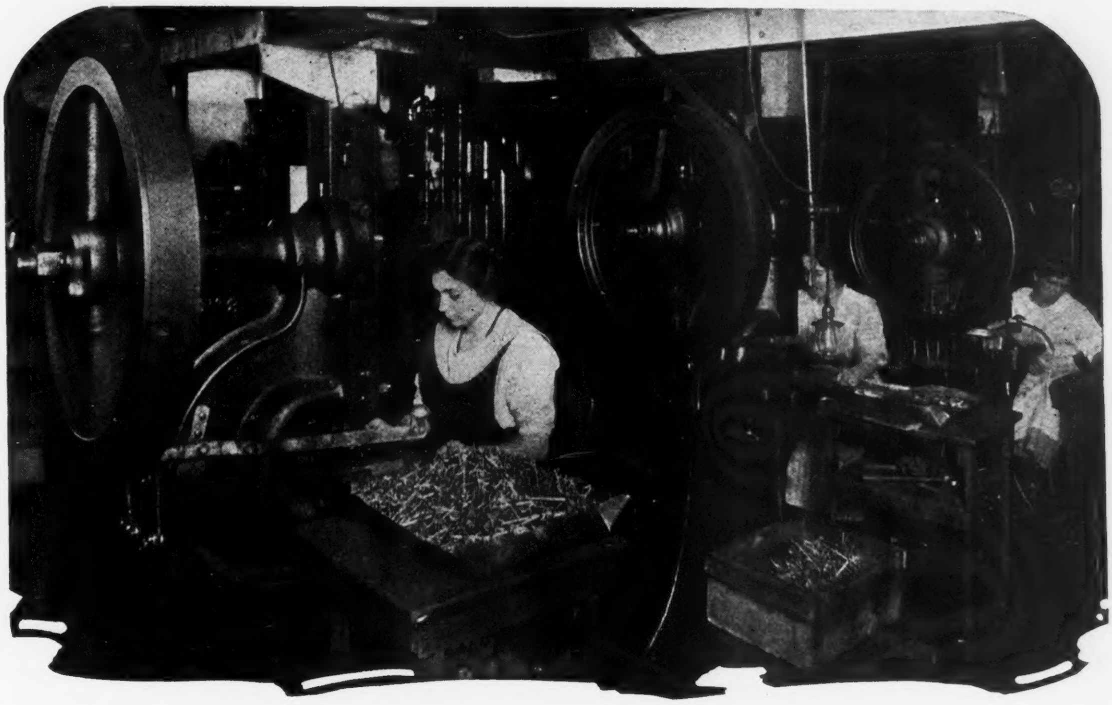

Photo by courtesy of our customer

Buying Service

An instance of the long, steady service given by BLISS Presses is afforded by the three "Stiles" type presses illustrated.

Twenty-three years ago they were purchased by their present owner from another firm in the West where they had been in use. All three presses are used continually 9½ hours a day and are still in good working condition. They are shown forming various small mechanical specialties and mechanisms. Eight to ten thousand pieces is their average working production.

Our 65 years of specialized effort in building sheet-metal working machinery insures your receiving equipment that successfully meets your requirements from the practical operating point of view. Every detail is the result of practical experience.

Bliss for Machinery

E. W. BLISS CO. MAIN OFFICE AND WORKS **BROOKLYN, N. Y., U. S. A.**

SALES OFFICES { DETROIT Dime Bank Bldg. CLEVELAND Cleveland Discount Bldg. CHICAGO Peoples Gas Bldg. PITTSBURGH Oliver Bldg. ST. LOUIS Boatmen's Bank Bldg. BUFFALO Marine Bank Bldg. CINCINNATI Union Trust Bldg. NEW HAVEN Second Nat'l Bank Bldg.

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No. 301


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Cut Glass
YET
it Can Be Bent in this State
SEMINOLE
UNBREAKABLE
HEAVY DUTY
CHISEL STEEL
Patent No. 1,468,937 1923
Let us tell you all about it.
ESTABLISHED LUDLUM 1854
SEMINOLE
The Unbreakable Chisel Steel

Found the best way—with

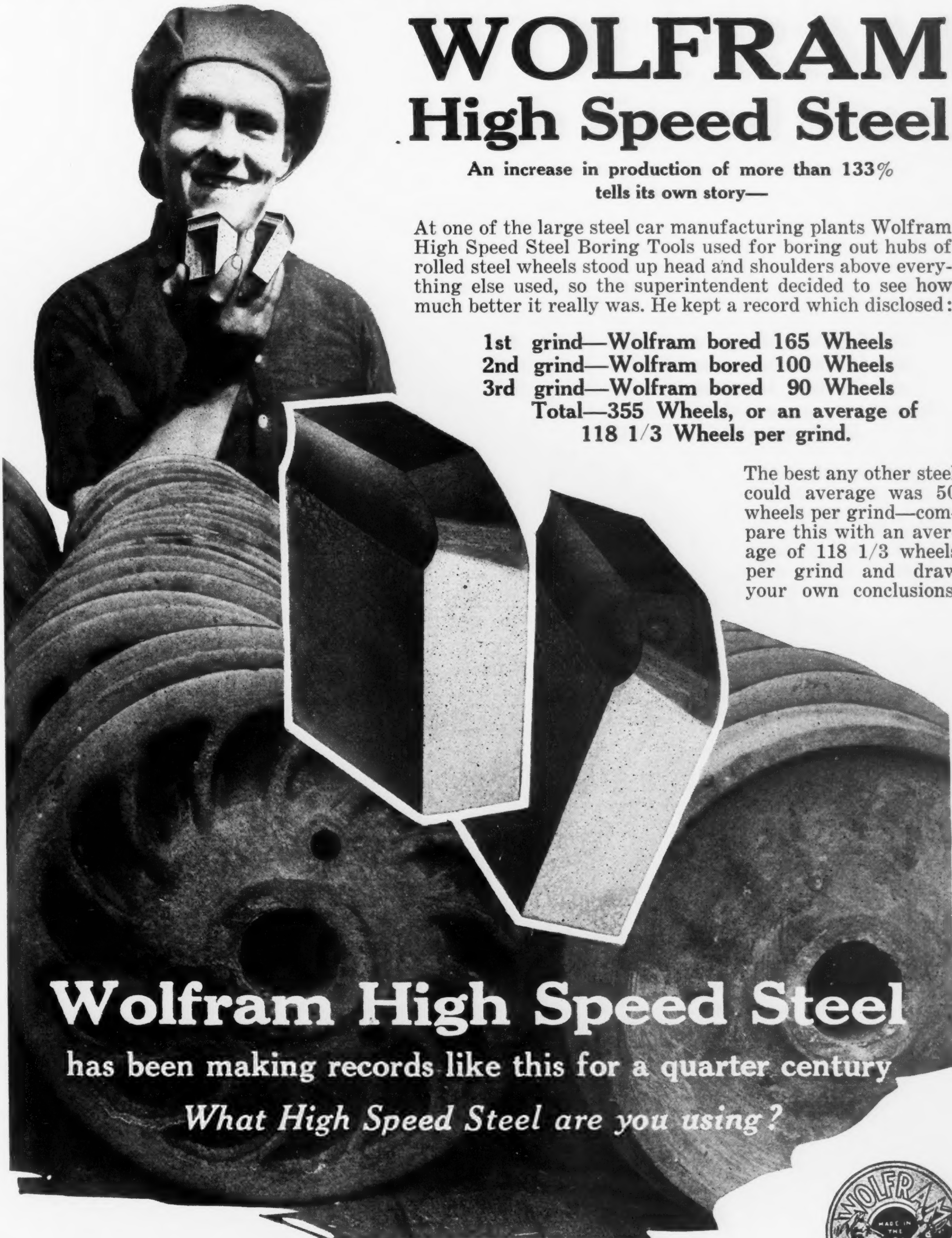
WOLFRAM
High Speed Steel

An increase in production of more than 133%
tells its own story—

At one of the large steel car manufacturing plants Wolfram High Speed Steel Boring Tools used for boring out hubs of rolled steel wheels stood up head and shoulders above everything else used, so the superintendent decided to see how much better it really was. He kept a record which disclosed:

1st grind—Wolfram bored 165 Wheels
2nd grind—Wolfram bored 100 Wheels
3rd grind—Wolfram bored 90 Wheels
Total—355 Wheels, or an average of 118 1/3 Wheels per grind.

The best any other steel could average was 50 wheels per grind—compare this with an average of 118 1/3 wheels per grind and draw your own conclusions.



VULCAN CRUCIBLE STEEL CO.
HOME OFFICE AND WORKS: ALIQUIPPA, PA.

Established 1900

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Chicago—16-18 South Clinton Street
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Detroit—4843 Bellevue Avenue
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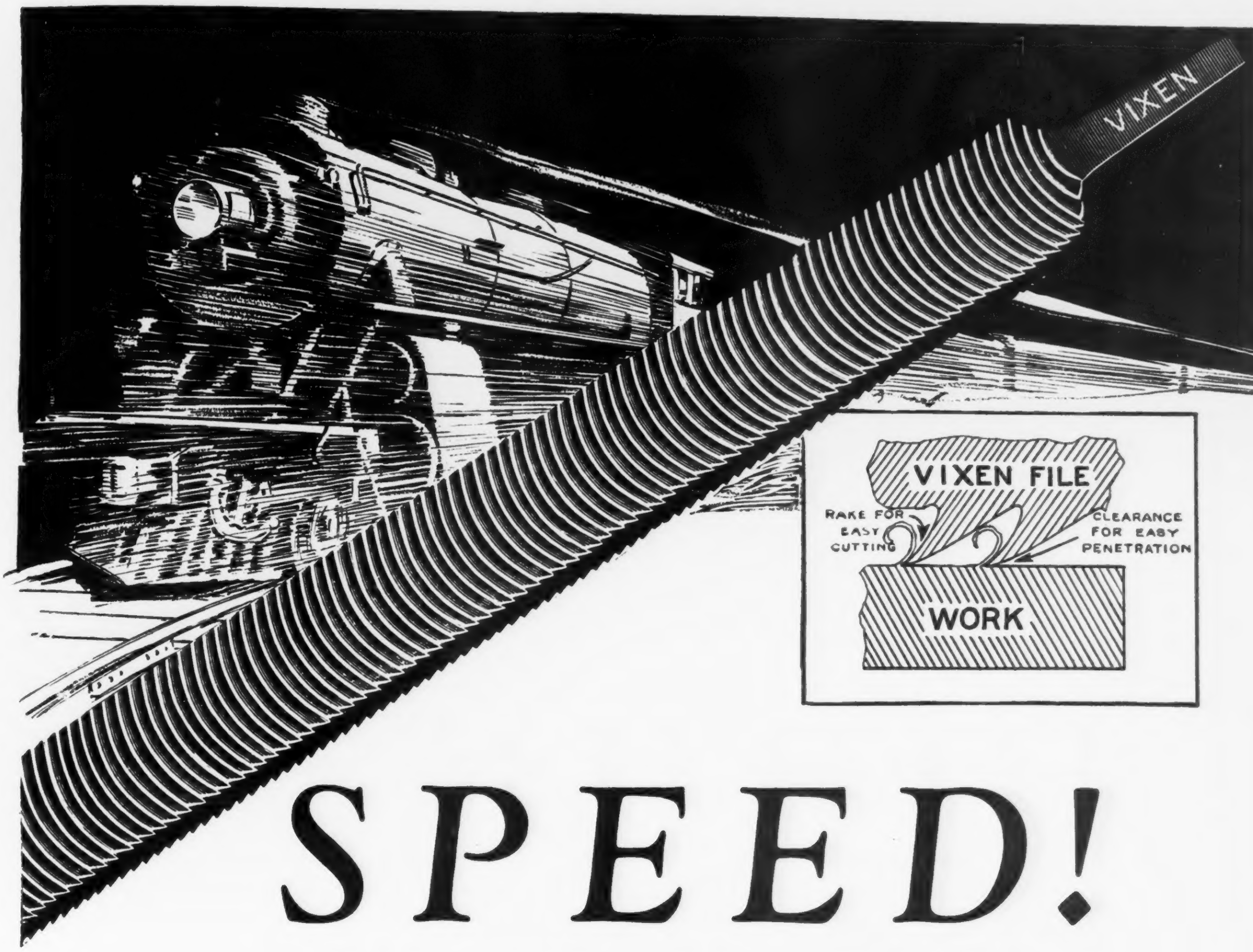

SPEED!

The accommodation train and the Flyer will both get you there. The ordinary file and the Vixen File both produce results, but if you want speed, ease, comfort, the saving of time and money, use Vixens whenever possible. [See diagram]

Special alloy steel gives the Vixen a lasting keen cutting edge with the proper rake and clearance angles that actually *shears* the metal instead of just pushing it off—and it clears itself of filings automatically. Each tooth is individually milled.

Specify your kinds of filing and test Vixens will be placed in your hands free of charge to prove their dependable speed and economy.

Time is money and Vixens save time. The various Vixen cuts can be used for hard and soft metals—fibre—marble—stone—slate—wood—rubber.

Your dealer will be glad to tell you more, or if you wish, write directly to us.

HELLER BROTHERS COMPANY
Newark, New Jersey, U. S. A.

VIXEN CURVED TOOTH FILES

Good News for the Diemaker!

Large stock of GROBET SWISS FILES—all shapes and sizes—now in our New York warehouse ready for shipment to the dealer in your city.

Fast cutting, long wearing, true shaped files; special favorites with skilled die makers and workers in the most exacting metal trades for more than a century.

Order Grobet Files now from your dealer; he has them or can get them at once.

Write us for Price List and Catalog

Grobet File Corp. of America

64 Reade Street, New York City

His File slipped—

This would have prevented injury

Costs Only a Dime

Send 10c for a sample Osgood's Safety File Grip, slip it over the unguarded tip of your file, and file with speed and safety. Once tried you'll never be without them.

J. L. OSGOOD TOOL CO.

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SOCIÉTÉ GENEVOISE
HIGH PRECISION EQUIPMENT

Designed for speed and accuracy in production manufacturing, it includes:

5 sizes of Jig Layout and Boring Machines.
4 sizes of Precision Screw-Cutting Lathes.
9 types of Universal Measuring Machines.
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8 models of Inspection Comparators.
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Internal and External Thread Grinding Machine.
Gear Testing Machine.
Machine for Setting Adjustable Snap Gages.

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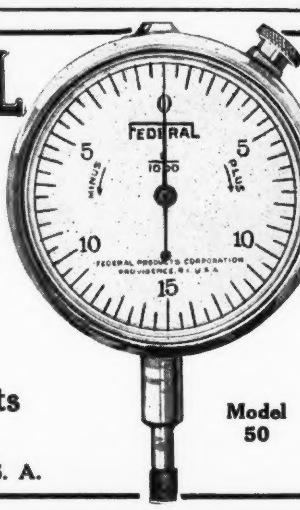
Dial Indicators

As simple and sturdy as dial indicators can be made. Easy to read, easy to use, easy to repair. A model for every purpose.

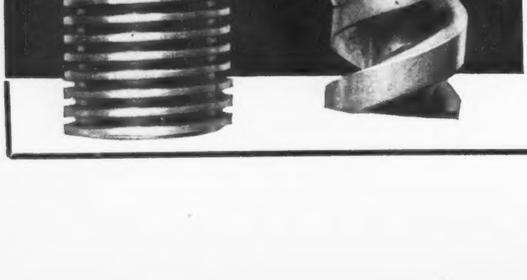
Catalog on request.



Federal Products Corporation

PROVIDENCE, R. I., U. S. A.

Model 50



HINDLEY SCREWS

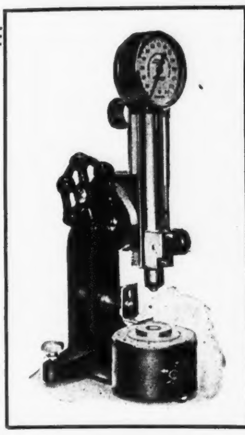
The most important step in the making of Hindley Screws is the cutting. Special machines remove metal without disturbing fibre. The best quality of metal is used and the finished product is closely accurate, beautifully finished, sturdy and serviceable.

MAY WE QUOTE ON YOUR REQUIREMENTS?

HINDLEY GEAR COMPANY

1105 Frankford Avenue, Philadelphia, Penna.

Confidence without a "?"

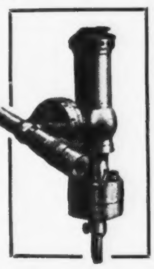


Would you be absolutely sure that your product is *right* before it leaves your factory? Would you have unquestioned confidence in its ability to serve users well and faithfully? This confidence can easily be yours if you test each piece of metal that goes into your product with

The Scleroscope

This machine measures the hardness of metal quickly and accurately—it is the best metal insurance; can be used everywhere; absolutely does away with all guesswork.

The Pyroscope



gives the precise temperature of metal in process of heat-treatment. Simple, durable and fool-proof.

Send for the Shore Booklet describing both machines and also the Shore Process of Selective Carbonizing and Hardening.

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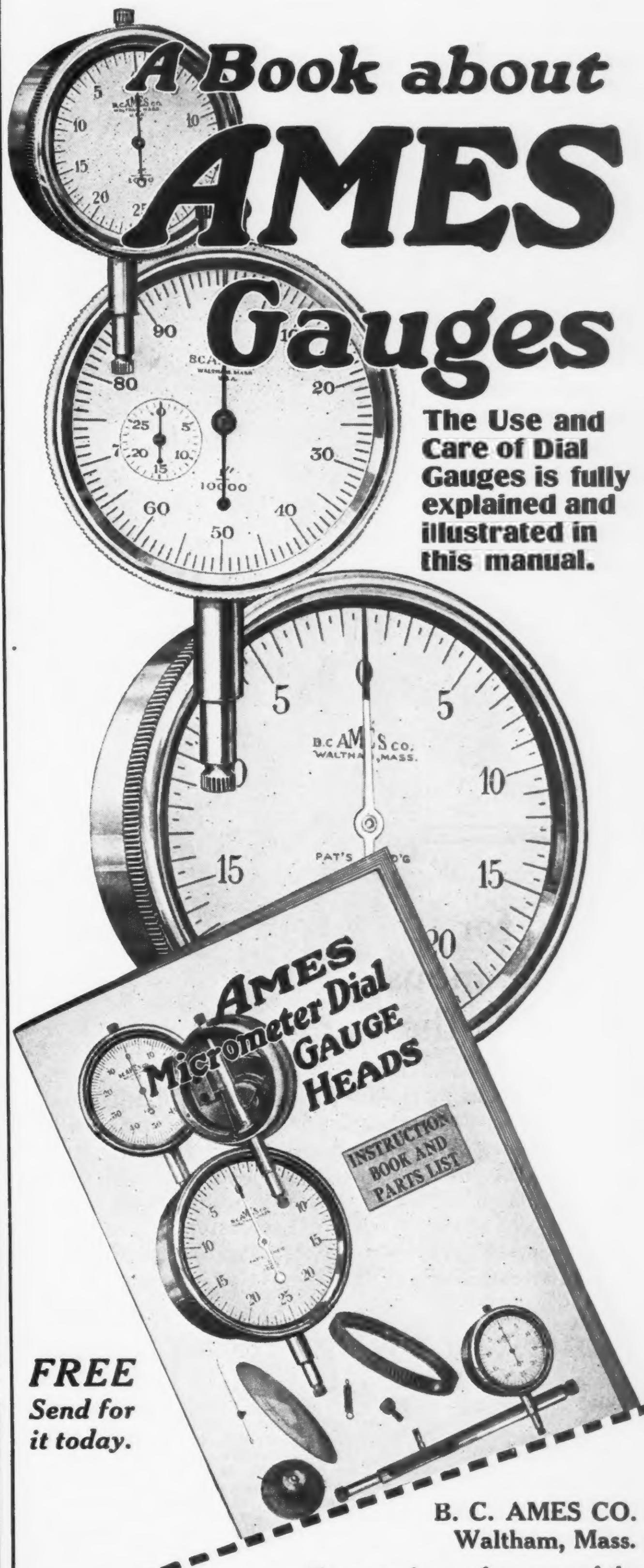
A Book about AMES Gauges



The Use and Care of Dial Gauges is fully explained and illustrated in this manual.

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M-8

Compact—Sensitive—Accurate—Durable

The "ATLAS JUNIOR" INDICATOR

Reads over a range of 0.055"—at a glance. Dial may be set at zero after adjusting to work. Contact point can be locked in position for inspecting. Keep it in your pocket and use it anywhere. Details?

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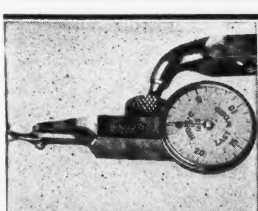

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UNIVERSAL
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Send for Folder

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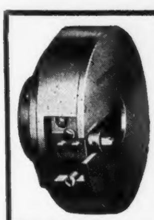

Facing on the Drill Press

Use the M-D Facing Head; it faces like a lathe, has a single point tool which travels radially from center outward or reverse; feeds automatically and faces diameters from 6" to 24". Details and prices?

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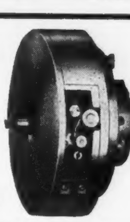
HANOVER, PA.



American Swiss Files

Look for The Famous Mark on the Tang

It is a silent, proven assertion of quality—the famous star and cross trademark, stamped on the tang of every **American Swiss File.** It is a guarantee that the file you are about to use is uniformly correct in design and cut and scientifically heat-treated—a sturdy tool for precision filing. Our new booklet describes and illustrates the full line of **American Swiss Files**—send for a copy.

American Swiss Precision Files

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American Swiss File & Tool Company
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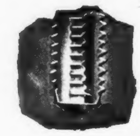
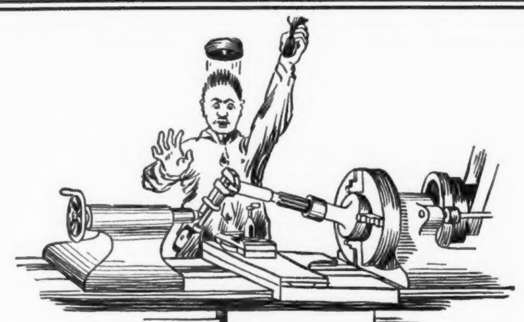
Of What Does This Remind You?



SUPPOSE that you had on hand when your first tap was broken, a commercial device built especially to remove the broken pieces of tap, a commercial device, not a home-made article, would you not have saved a great deal of time?

Write Us for Information

The Walton Company
310 PEARL STREET HARTFORD, CONN.

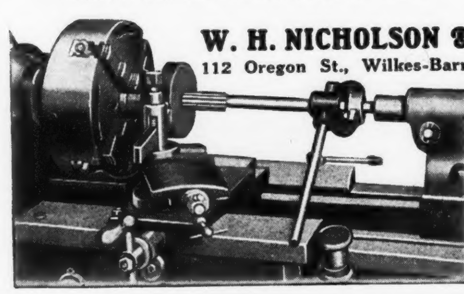


A Foolish Risk

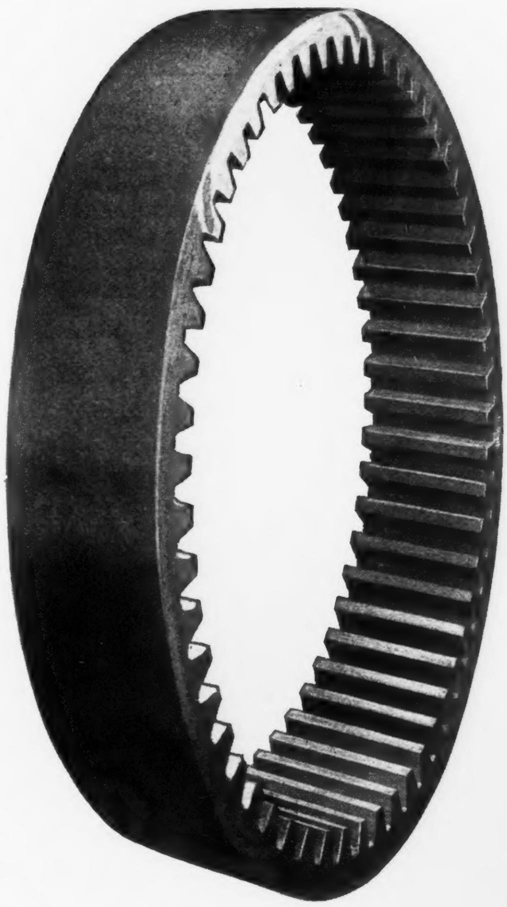
A reamer was never meant to be held to the tailstock with a wrench. When there's a slip there's trouble—spoiled work, and sometimes an injured workman. Avoid trouble by using the Nicholson Reamer Holder. Can also be used in place of a drill chuck and as a hold-back in a lathe.

May we send one on trial? Just send us a sketch of socket or number of Morse Taper of Lathe.

W. H. NICHOLSON & CO.
112 Oregon St., Wilkes-Barre, Pa.



Bang! Bang! Bang!



Phillie Gear's fist thumps the desk—"That order must go out tonight—the customer is waiting for it and we cannot fail him." This means no interruption in Phillie's smooth running organization—simply emphasizes his policy of immediate service to his customers.

This policy, together with the high quality of his gears, has won Phillie Gear unchallenged leadership in the delivery of gears how, where and when they are wanted. Phillie Gear's plant is gear "headquarters" for manufacturers from one end of the country to the other. *Get his prices!*

Philadelphia GEAR Works Philadelphia

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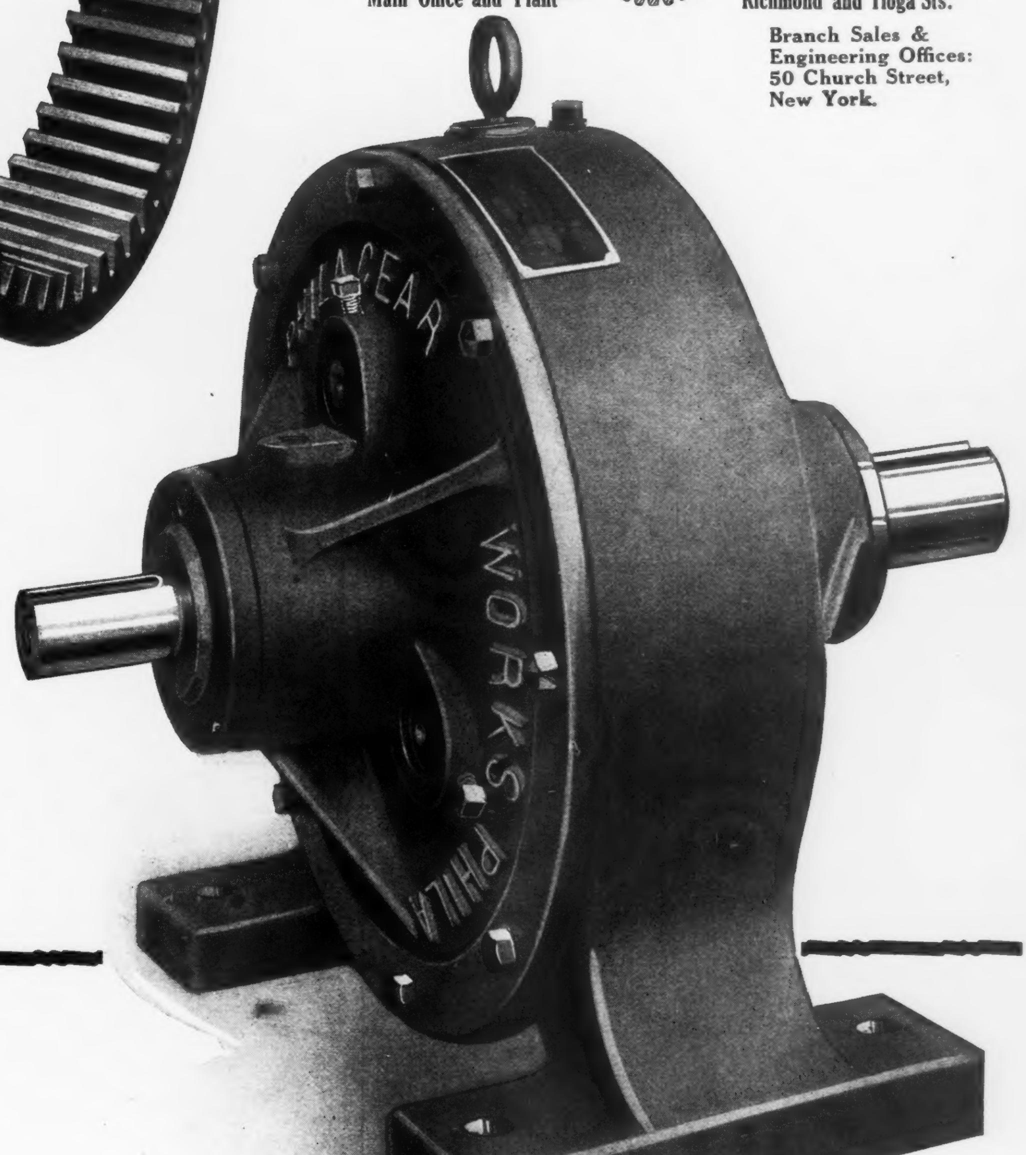

P. S.: Send for— THE GEAR BOOK

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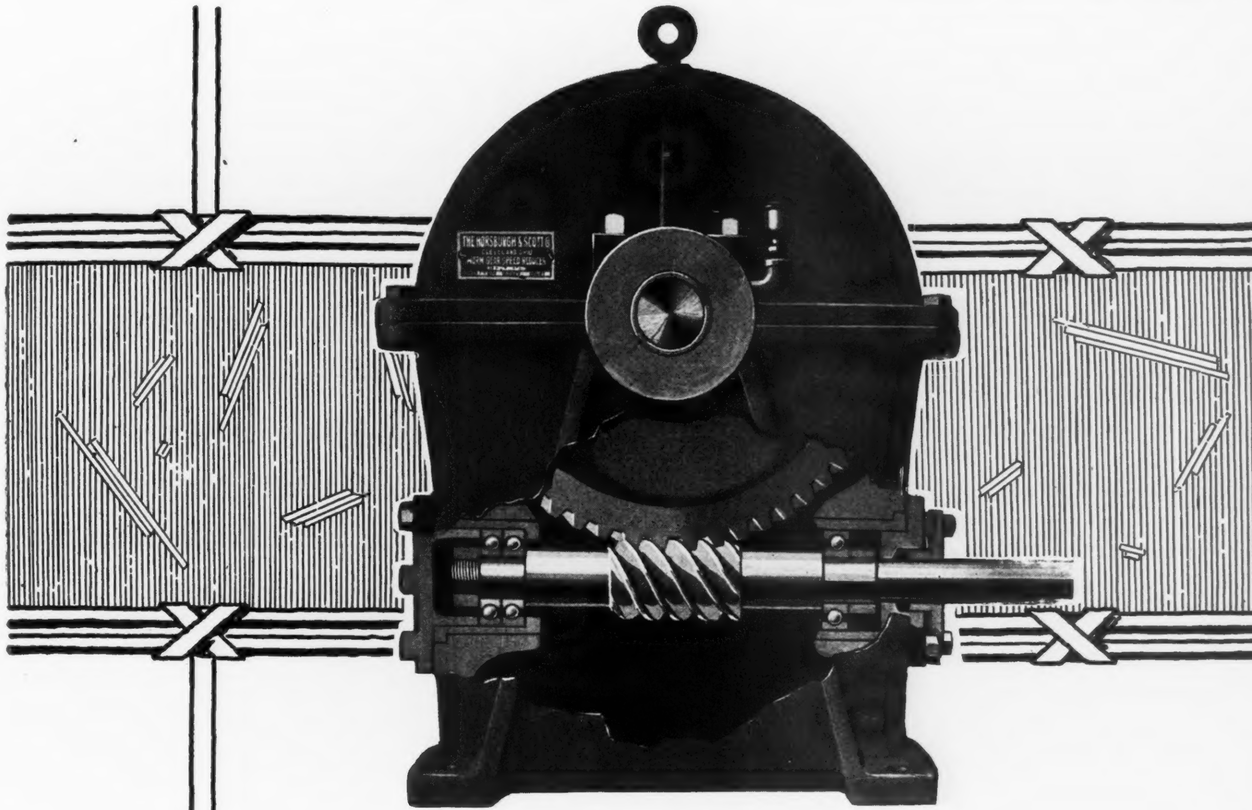

EVERY
INDUSTRIAL
GEAR

BEVEL
SPUR
SPIRAL
HERRINGBONE
WORM

SPEED
REDUCERS

RAWHIDE-
BAKELITE
PINIONS

HARDENED
HEAT-TREATED
GEARS

The Result of Thirty-Six Years of Development

Horsburgh & Scott gear service today stands as the result of thirty-six years of steady, healthy development.

From a small beginning we have slowly expanded until we now have 75,000 square feet of floor space and 140 machines devoted exclusively to the manufacture of industrial gears.

The only answer to this continued growth in our business is that gear users have found that, in our service, which made it worth their while to come again and to send their friends to us.

The Horsburgh & Scott Co.
Cleveland, Ohio

Hardened Steel Gears

Special Facilities

Specialized Experience

Here are glimpses of some of the up-to-date equipment that makes Pittsburgh Hardened Steel Gears so thoroughly reliable. Modern hardening furnaces, accurate heat measuring and controlling apparatus and scientific testing instruments operated by experts.

Pittsburgh Gears earn their reputation as superior products by the quality of workmanship and material that is put into their manufacture.

Hardened steel gears, rolled blank bevel gears, bakelite gears—any gears you need for any purpose.

All Pittsburgh Gears are Carefully Tested

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2700 Smallman St., Pittsburgh, Pa.

REDUCING GEARS

The Speed Reducing Gear shown by this cut is our No. 2, large reduction, small H.P. load.

Manufactured by us and carried in stock by us and our dealers for immediate delivery.

Used extensively in experimental laboratories and as an integral part of other machines. See a description in our

Booklet No. 21

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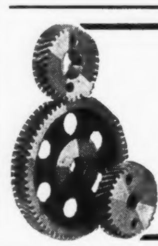
Adams GEAR HOBBERS

Write for Catalog No. 809

THE ADAMS COMPANY 1910 Market Street Dubuque, Iowa, U. S. A.

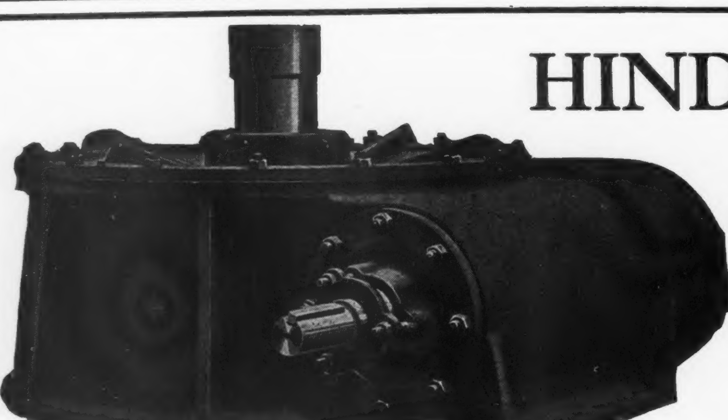


Bevel Gears—Sprockets

Raw-Hide Pinions

STRANAHAN GEAR COMPANY
FRANKFORD JUNCTION—PHILADELPHIA, PA.

HINDLEY GEARS



These are the gears to trust with heavy loads and high speeds. Put them where faultless performance is vital. The sturdiness for such hard tasks is built into Hindley Gears by an organization that knows how.

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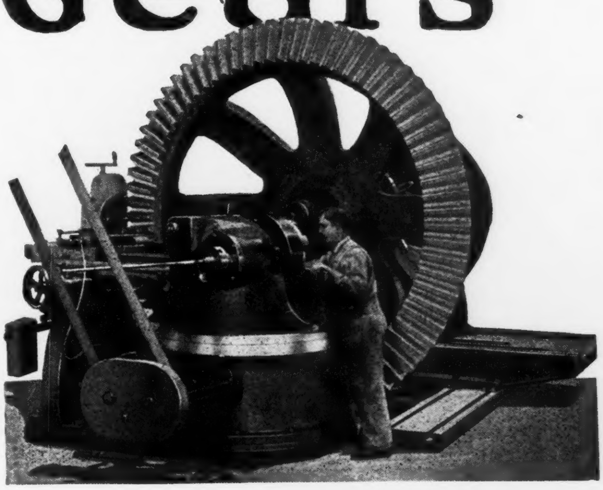
Earle Gears



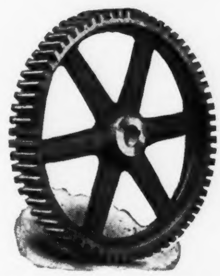
Big gears, produced by specialists, in a specially equipped plant are bound to be better, more economical—they have that "something" which only specialization can give them.

Earle Gears in all sizes.
Send blueprints for estimates.

The Earle Gear & Machine Company
4707-15 Stenton Ave. Philadelphia

Manufacturers of Earle Gears; Earle Centrifugal Pumps; Lea-Simplex Cold Saws; Earle Bridge Operating Machinery.

GEARS



All kinds—types and sizes.

16,000 different fixtures.

Made by improved machine moulding method.

A skilled organization of 82 years' experience.

A gear service unequalled.

Catalog 258 Sent By Request

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Gear Makers since 1843 BALTIMORE, MD.

CUT GEARS and SPEED REDUCERS

ALLING-LANDER COMPANY, INC.
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BEVEL GEAR GENERATORS

All Types of Gears, also
SKEW BEVEL GEARS

Special facilities for ***straight*** and ***spiraloid*** Bevel Gears

The Bilgram Machine Works
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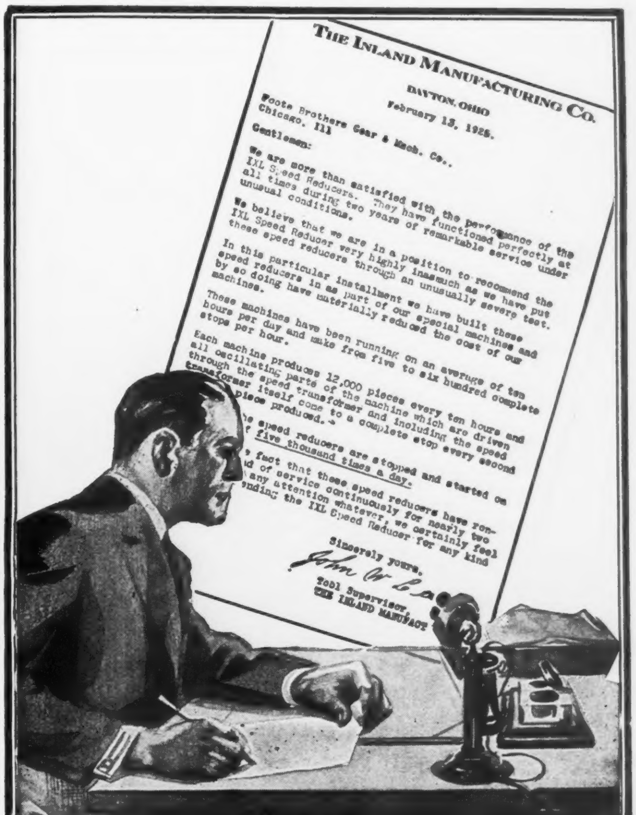


Three Million Times In Two Years

THE Inland Manufacturing Co., Dayton, Ohio has given IXL Speed Reducers a real test on their special machinery.

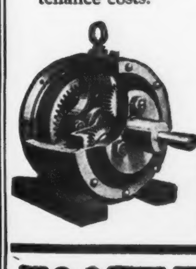
A number of IXL SPEED REDUCERS, Size T3-8 with a ratio of 45.79 to 1 have been started and stopped 5000 times a day for over two years . . . or more than 3,000,000 times! And they are still on the job—just as good as ever.

This demonstrates that good design, careful workmanship and fine materials are certain to give unusual performance.

Wherever you have power to deliver at reduced speeds to driven machinery IXL Spur and Worm Gear Speed Reducers will do the job better, safer and more economically than it can be done by any other method.

Let us tell you how IXL Reducers will save power losses, conserve valuable space and reduce your operating and maintenance costs.

Established 1895



IXL Spur Gear Speed Reducer

Send for Our Free Reducer Book

FOOTE BROS. GEAR & MACHINE CO.
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Sales offices in all principal cities in U. S. and Canada

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Please send without obligation a copy of the Foote IXL Speed Reducer Book.

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TWIN DISC CLUTCHES

Model F, for Better Machine Drive Control

In every modern shop and factory there are places where the use of Model F Twin Disc clutches would result in decided economy.

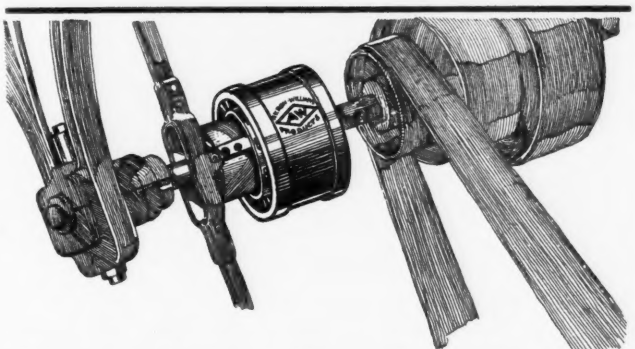
These clutches are designed for use as couplings on line shafts, as drives for pulleys or for spiders carrying pulleys, sprockets or gears. They may be used in group drive installations or as controls for individual machines and in every case will give superior service.

Model F clutches have the smooth, positive engagement, the firm grip, the strength, resistance to wear and the simple take-up adjustment that have made Twin Disc clutches acknowledged leaders in heavy duty service.

Install a Model F clutch at the most troublesome point in your shop. Note the low first cost. Watch the results. Then let our engineers figure with you for installations at all critical points.

TWIN DISC CLUTCH COMPANY
RACINE WISCONSIN

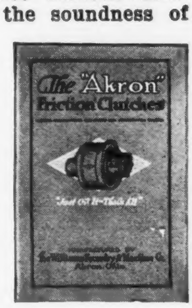
Pacific Coast Representative, F. Somers Peterson Co., 57 California St., San Francisco



Just oil it—that's all

The AKRON Friction Clutch runs in oil which makes it unusual in that it can slip under overload without damage.

Many instances of long, trouble-free service without interruption or replacement of parts prove the soundness of "AKRON" clutch design. Some of the original installations have run 12 years with no expense except for replenishment of oil.



It will pay any manufacturer to investigate the "AKRON" clutch when planning replacement or new installations of machinery.

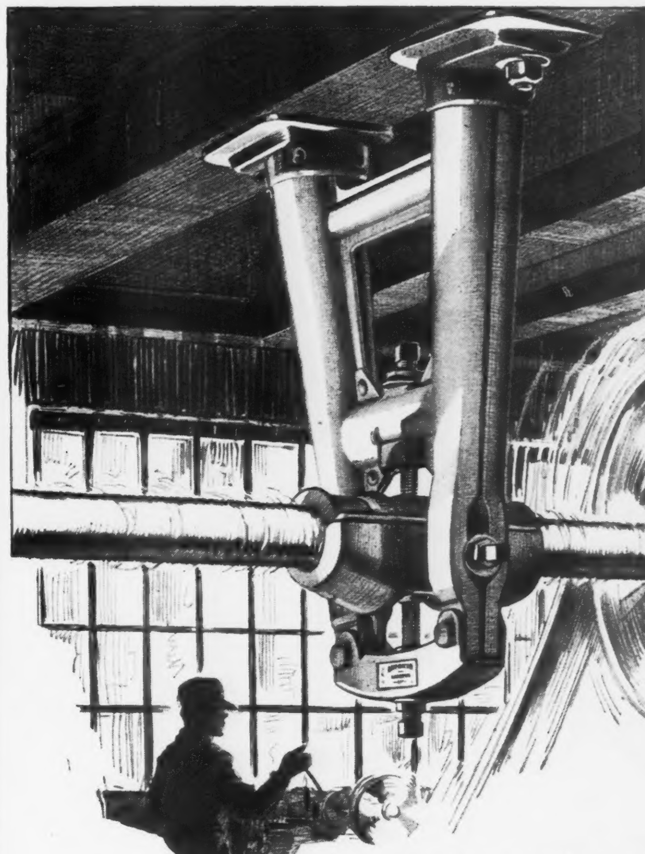
Manufacturers of machines requiring clutches will find the AKRON clutch highly desirable as an accessory or part.

Send for this catalog. Put your clutch problems up to our engineers.

The Williams Foundry & Machine Co.

"In Business Since 1888"

64 CHERRY STREET AKRON, OHIO



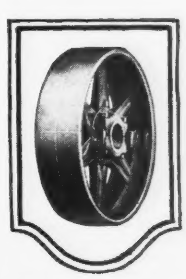
"THE FINEST PIECE OF METAL STAMPING I EVER SAW"—

THIS was the initial remark of an industrial engineer after he had looked over his first American Pressed Steel Shaft Hanger.

Then, as he carefully examined in detail the construction of the hanger, he noted the design, the unusual strength and rigidity against vibration; the smooth, round surfaces, without dust pockets, that make for cleanliness; absence of projecting parts that assures safety; the provisions for quick and accurate adjustments and the graceful lines that contribute to the appearance of any shop which is equipped with American Pressed Steel Hangers.

Not only is the American Pressed Steel Shaft Hanger an example of fine, accurate metal stamping, but it embodies all the engineering principles that assure satisfactory performance.

An interestingly illustrated folder fully describes this hanger. Send for your copy.



THE American Steel Split Pulley is used in every country where manufacture is an important industry.

The American Pulley Company

Manufacturers of Steel Split Transmission Pulleys, Pressed Steel Shaft Hangers and Pressed Steel Shapes

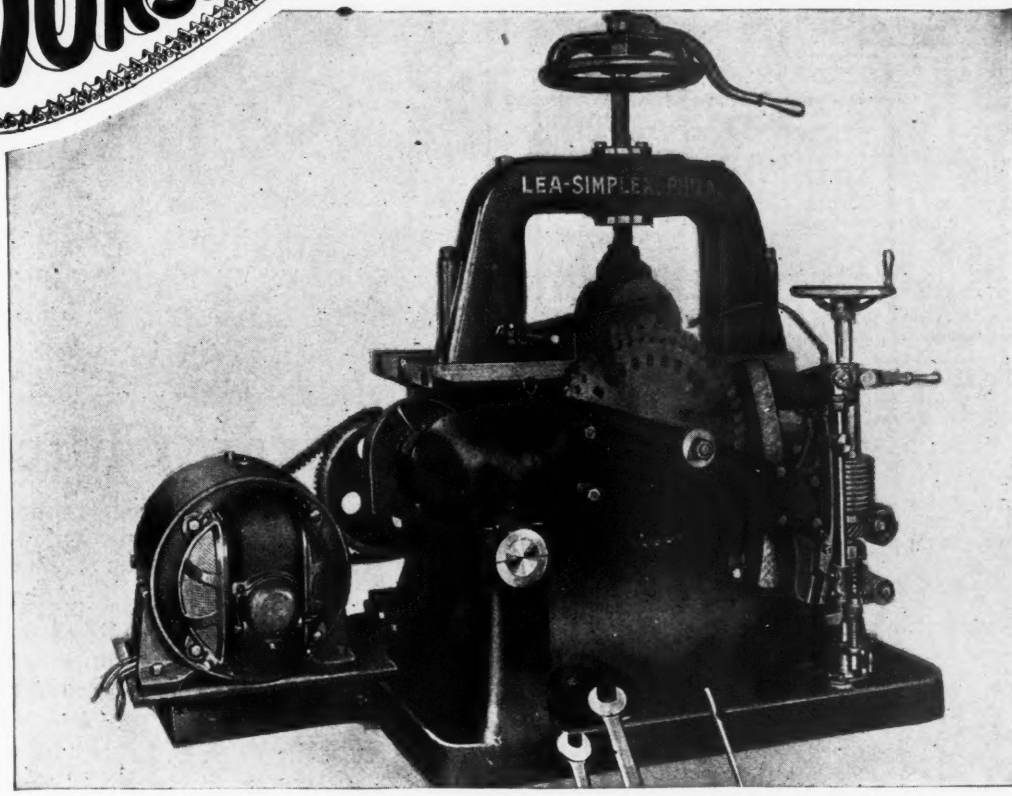
4200 Wissahickon Ave. Philadelphia

For the nearest "American" dealer see MacRae's Blue Book

AMERICAN

PRESSED STEEL HANGERS PATENTED | **STEEL SPLIT PULLEYS** PATENTED

MORSE SILENT CHAIN DRIVES



Morse Silent Chain driving cut-off saw.

Heavy Cuts at Uniform Rate

Machine tools, driven by Morse Silent Chains, operate smoothly and quietly without shock, jar, chatter or slip.

A greater output is possible with a reduction in maintenance expense as well as elimination of inferior work and rejections.

Morse Engineers are at your service for planning your individual requirements—write the one nearest to you.

MORSE CHAIN CO., ITHACA, N. Y.

There is a Morse Engineer near you

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BOSTON, MASS..................141 Milk Street
CHARLOTTE, N. C.......404 Commercial Bank Bldg.
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SAN FRANCISCO, CAL..Room 355, Monadnock Bldg.
ST. LOUIS, MO., Railway Exchange Bldg., Morse Chain Co.
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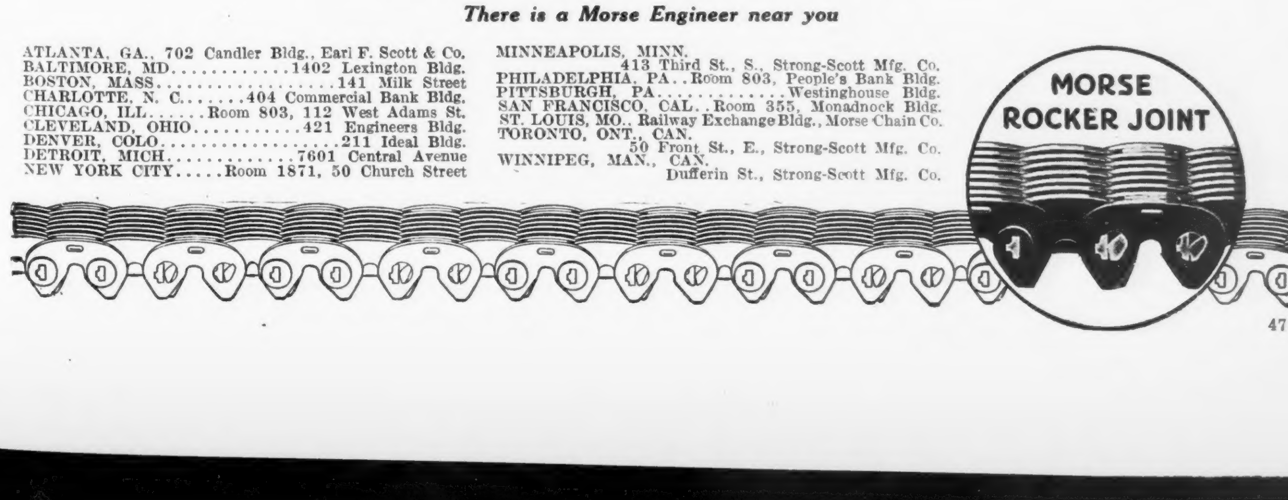

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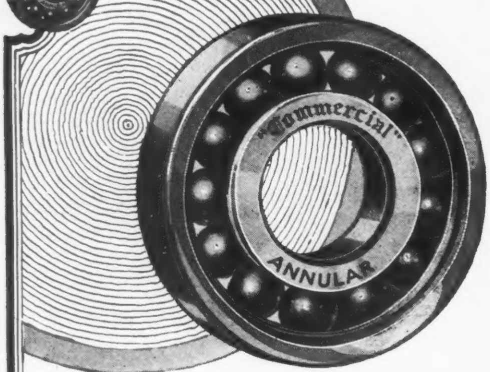
BUNTING



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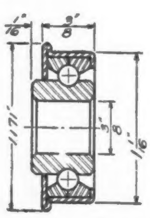
ANNULAR BALL BEARINGS

IN YOUR PRODUCT

Moderate cost, long service, high efficiency—what more can you ask? These are the factors which have created a nation-wide demand for "COMMERCIAL" Annular Ball Bearings. They are readily adaptable to all classes of service and not only sustain thrust loads of 50% of their radial load, but sustain radial and thrust loads *simultaneously*.



A TYPICAL INSTALLATION

This type A "Commercial" Annular Ball Bearing—CS-643—is one of an unlisted series for shafts from 3/16" to 3/4" diameter. Extensively used for conveyors, counter-weight sheaves, small wheels, machines of various kinds, etc. The flange in many cases simplifies and reduces the cost of assembly.

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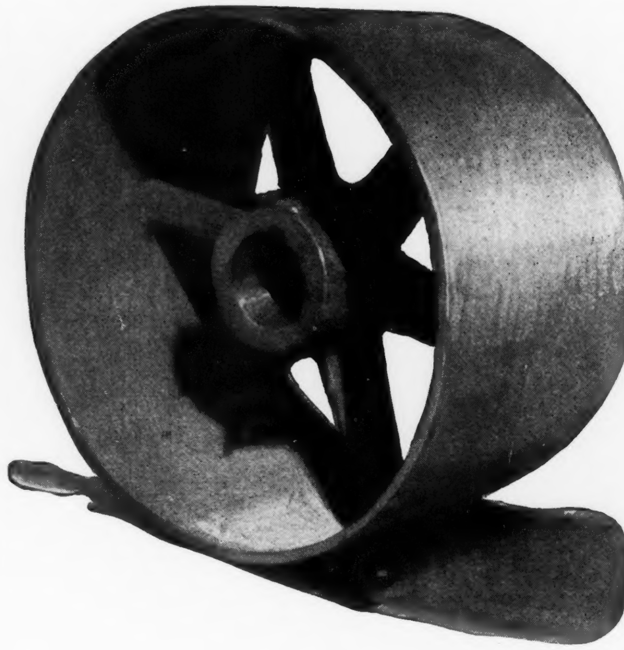

When You Order Pulleys

Be sure, when you again need pulleys, to find out the service you can get from Jones.

In addition to cast iron pulleys that are skillfully molded, accurately balanced, and carefully machined, you get a source of supply that is dependable.

Our Catalogue No. 30 will show you how broad our service is and how reasonable our prices. Write for it.

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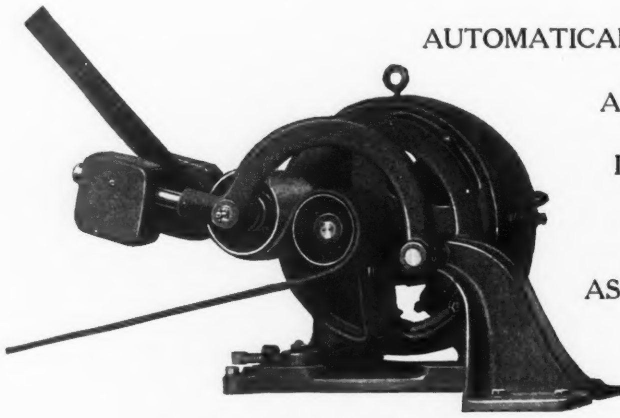

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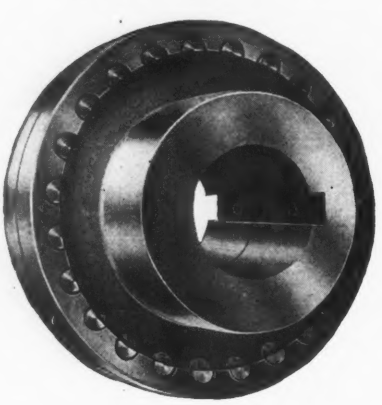
New England Branch: Cambridge, Mass. **Dealers in Principal Cities.** **Southern Office: Greenville, S. C.**

FRANCKE FLEXIBLE COUPLINGS

"They make good machines last longer"



Good machines deserve good couplings. That is why so many experienced engineers specify and use "Francke" Flexible Couplings on direct-connected drives—to make harmless any misalignment strains.

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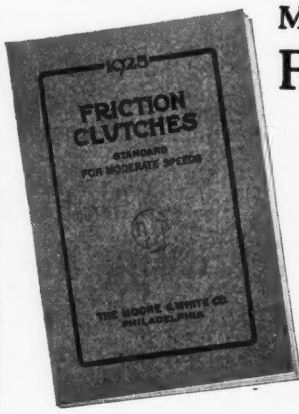

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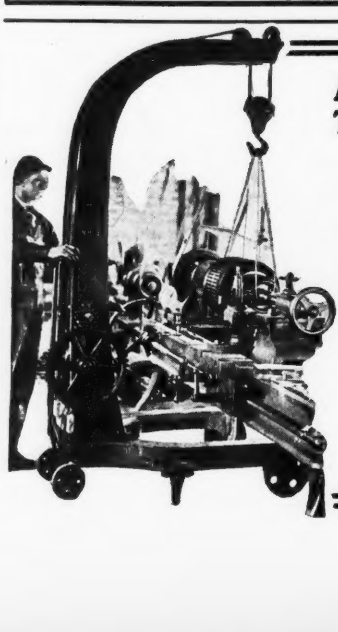

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"The Handiest Tool in the Shop". Write for details.

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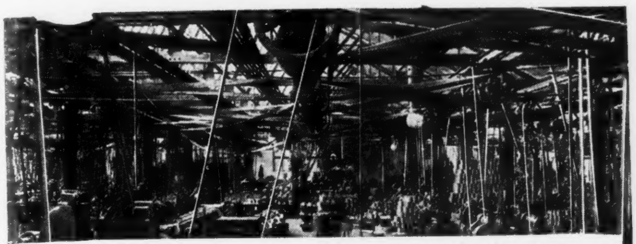

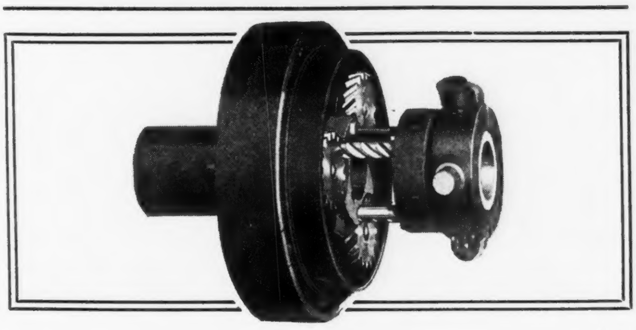

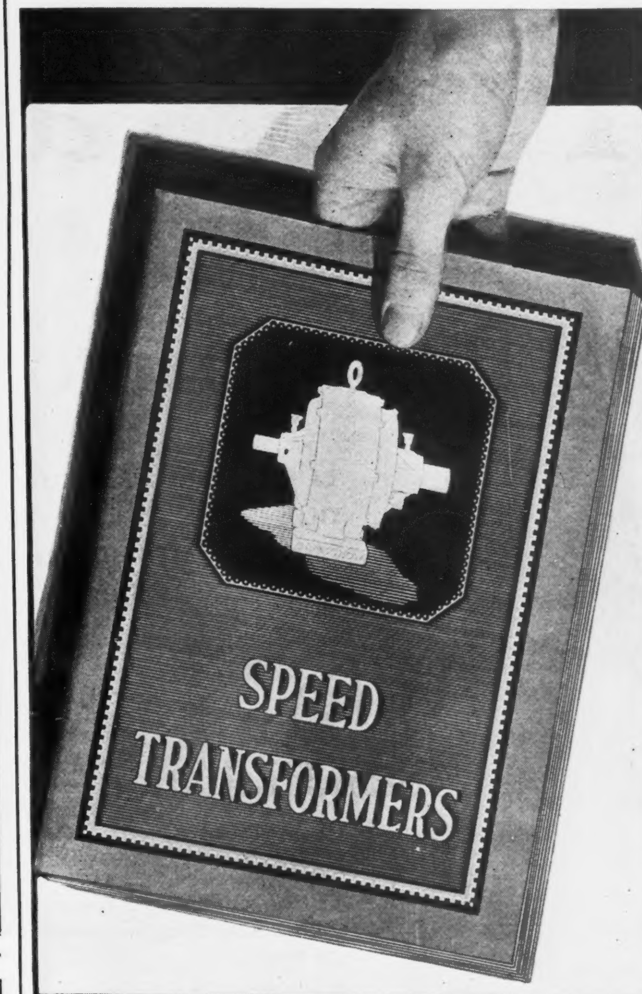
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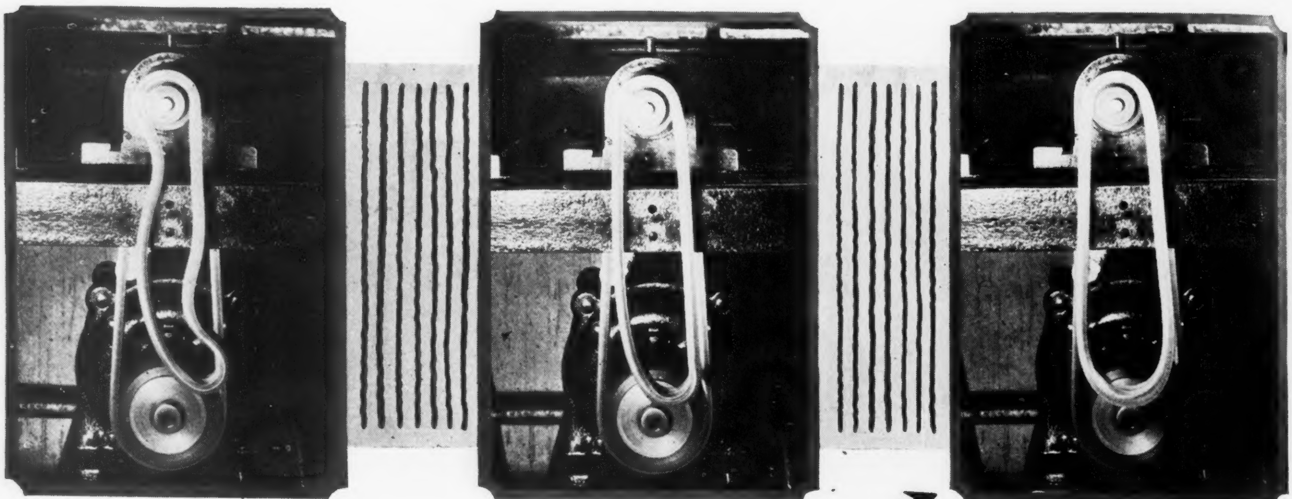
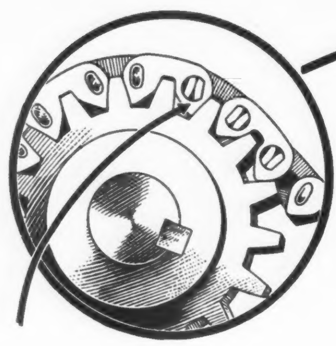
TRANSFORMERS



No. 1 No. 2 No. 3



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Compensating Joint
(Patented)

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An interesting Demonstration!

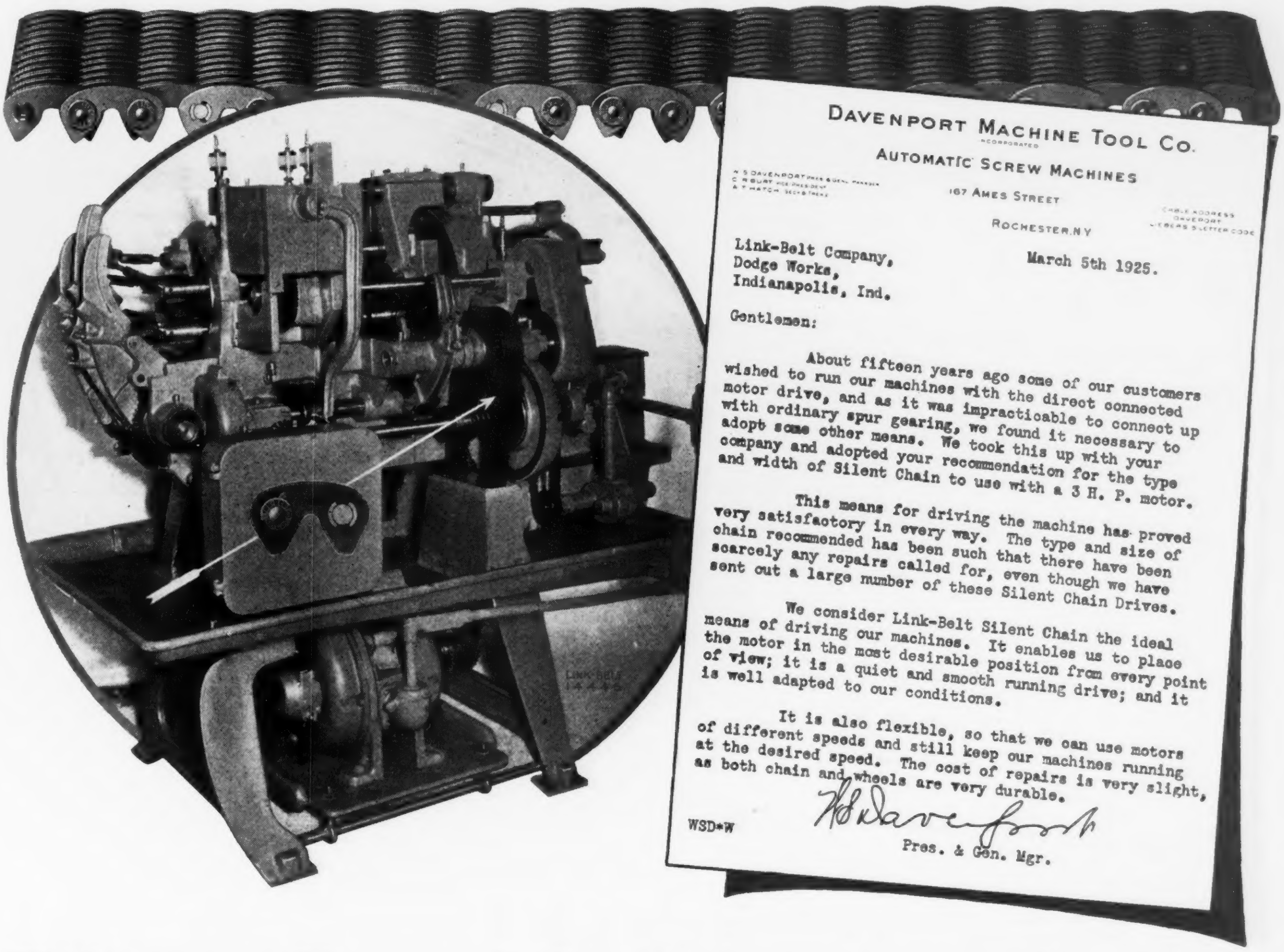
Two Commercial Silent Type Chains of other makes —together with a Ramsey Silent Chain were freely suspended upon 14-tooth sprockets turning at 1800 r.p.m. They assumed the positions shown in the above photographs. The resulting curious convolutions in Nos. 1 and 2 are caused by *Friction* generated within the joints—the Ramsey Chain (No. 3) assumed practically the same form in operation as at rest, excepting a slight widening of the loop at the bottom caused by Centrifugal Force.

The Roller Bearing Compensating Joint Structure incorporated in Ramsey Silent Chain *reduces Friction*—with consequent wear—to a minimum and transmits smooth, vibrationless power at high velocities—quietly and without heating.

Are these characteristics of value to you? If so send us your name and address and we will mail you a copy of our text book—"Power Transmission with Ramsey Silent Chain."

RAMSEY CHAIN CO., Inc.
1039 Broadway, ALBANY, N. Y.

Ramsey
SILENT CHAIN DRIVES



DAVENPORT MACHINE TOOL CO.
INCORPORATED
AUTOMATIC SCREW MACHINES
167 AMES STREET
ROCHESTER, N.Y.

Link-Belt Company,
Dodge Works,
Indianapolis, Ind.

March 5th 1925.

Gentlemen:

About fifteen years ago some of our customers wished to run our machines with the direct connected motor drive, and as it was impracticable to connect up with ordinary spur gearing, we found it necessary to adopt some other means. We took this up with your company and adopted your recommendation for the type and width of Silent Chain to use with a 3 H. P. motor.

This means for driving the machine has proved very satisfactory in every way. The type and size of chain recommended has been such that there have been scarcely any repairs called for, even though we have sent out a large number of these Silent Chain Drives.

We consider Link-Belt Silent Chain the ideal means of driving our machines. It enables us to place the motor in the most desirable position from every point of view; it is a quiet and smooth running drive; and it is well adapted to our conditions.

It is also flexible, so that we can use motors of different speeds and still keep our machines running at the desired speed. The cost of repairs is very slight, as both chain and wheels are very durable.

W S Davenport

WSD*W

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Fifteen Years' Satisfactory Service

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Because this drive is 98.2% efficient (on actual test), maintains positive velocity ratio, is quiet and smooth running, flexible, compact, durable and trouble-free, it saves money for its users. It saves lost production time, increases output, improves the finished product, and costs less in repairs and maintenance.

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Let us prove ourselves by facts.

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We can help you get the *most* out of your equipment. No obligations for complete details.

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Engineers, Machinists, Iron and Steel Founders.

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TRADE **MEHL MADE** MARK

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JIGS, FIXTURES, DIES, GAGES AND SPECIAL MACHINES

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Spindles and Machine Parts

Made with precision from material of special formula to meet the severe demands of each operation in

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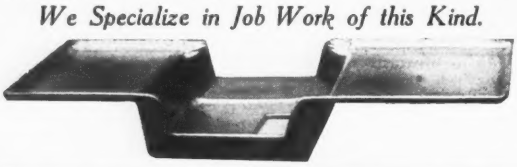
Several users of quantities of sheet metal parts who heretofore have made up their own parts were surprised when we figured our costs with them. Any manufacturer whose cost of production is under $20,000 per year will find we can reduce his sheet metal costs because

We Specialize in Job Work of this Kind.



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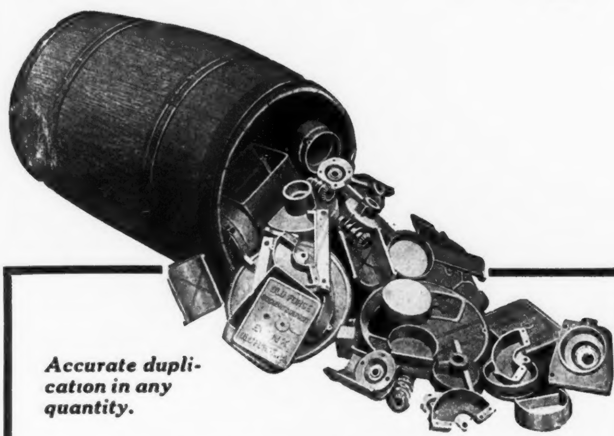

Accurate duplication in any quantity.

Consider the saving possible in the use of die castings in place of sand castings. Not only is it possible to secure a casting which is closer to specifications and with thinner walls; but many operations can be eliminated —no finish machining in special jigs are required.

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We specialize in Die Castings of Zinc, Tin, and Lead base Alloys

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For Strength, Uniformity and Economy

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Consult our Engineering Department on your die-casting problems. Your inquiries will receive prompt attention.

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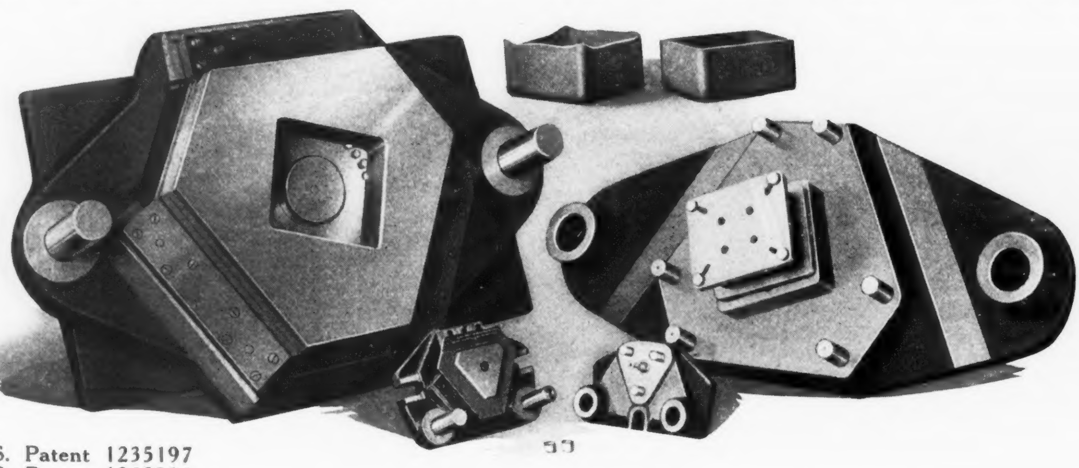

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Do you know the weakest link in your machinery?

It's your bearings. When they break down, everything stops — employees, production and profits.

Neglect in handling your lining metal problems often results in many dollars loss in shutdowns.

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is the ideal bearing metal for all general lining purposes, because being made from virgin metals by the AJAX PROCESS, it wears longer and runs cooler than babbitt.

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Yet Dyson prices are no more than you expect to pay for any good forging. Remember that fact when considering where you will send the next order.

Anything from a 3 inch nut to a 5 ton shaft

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Let us quote on your requirements. We can probably save money for you on high-grade parts of this character. Send blueprints or sketch.

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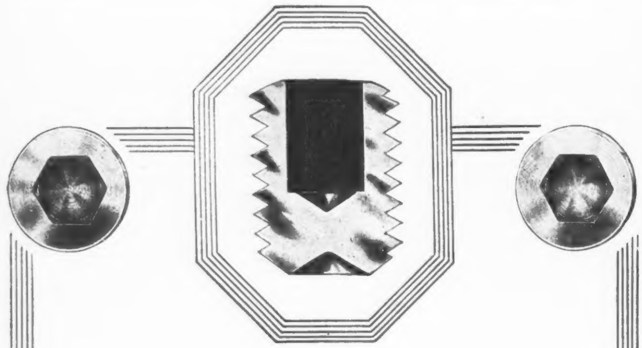

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Your special problem in Hollow Screws is getting the *strength* in the sizes and styles you need.

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The specification of special-analysis alloy steel; the cold-drawing process; the scientific heat-treating: —all are the work of hollow screw *specialists.*

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The "How to" Booklet describes this interesting tool and process.

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It took only one minute to *drill* this hole with a Watts Chuck and Drill. Compare that with broaching time for the same operation. The hole is ⅝" hex. ¾" deep, in cold rolled steel, sides smooth, bottom square with sides, and error in any dimension not over 0.002".

With the inexpensive Watts Chuck and Drill on your present machines you can drill triangular, square, pentagonal, hexagonal and octagonal holes almost as fast as round hole drilling and at a fraction of the cost by any other method.

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Adjustable Spacing Collar
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Hardened Ground

SAVE SET-UP TIME

Make positive and parallel adjustments in steps of .002" without removing cutters from arbor.
Stock sizes for ¾" to 2½" arbors, sent on approval.

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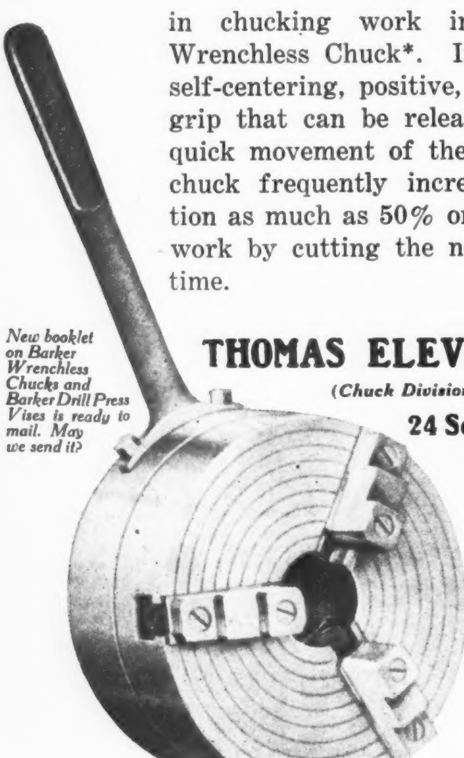

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Reversible Jaws of Sweetland Chucks work independently or universally—independent and reversible for odd shaped work and universal for speed on production work. In other words, the Sweetland is good for *all chucking.*

Sizes 6" to 24" in 3" steps; to 42" in 6" steps. Ask for Catalog 13-C.

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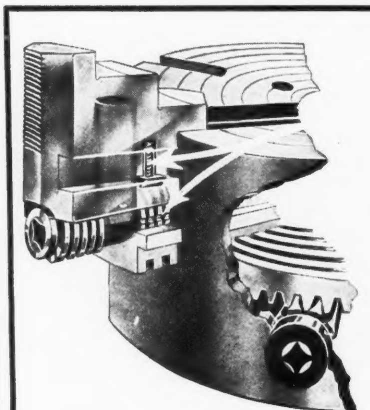

The New Tri-Plex Chuck

Self-Centering
Independent
Eccentric

Described in Catalogue No. 42

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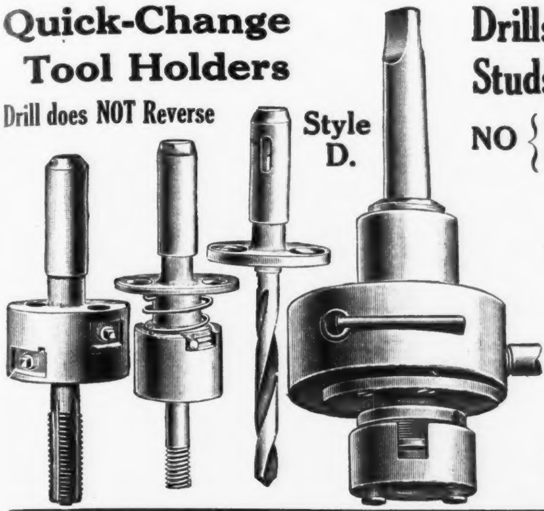
Quick-Change Tool Holders

Drill does NOT Reverse

Style D.



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Simple Methods of Handling Work
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Positive, Friction and Interchangeable Tapping Devices
TO MEET
Every Condition of Tapping
MADE IN ALL SIZES FROM 1/16-IN. TO 2-IN. TAPS
Use Style D for work that is clamped down or work that is too heavy to center itself to the tap.

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For every chucking requirement. Adaptable to all types of machines.

Arbor Presses	**Expanding Arbors**
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Operating Valves—Automatic, Hand or Foot Controlled, Reducing Valves and Automatic Lubricators.

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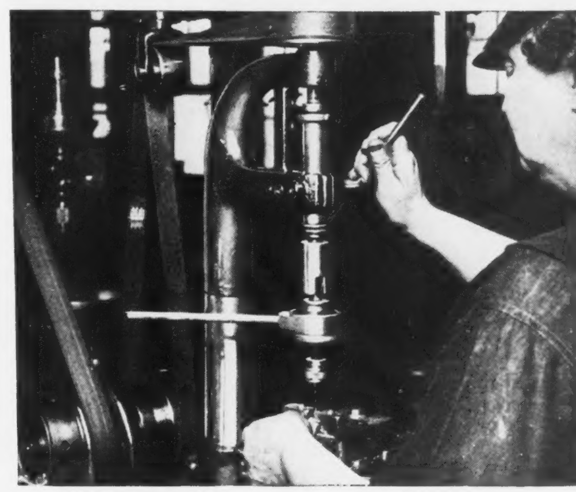

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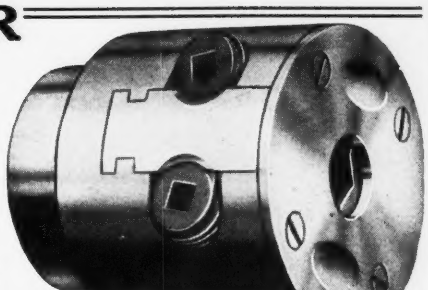

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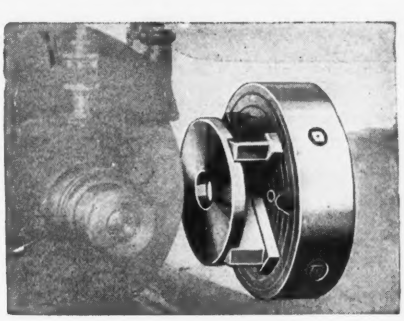

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NEW BRITAIN, CONN U.S.A
ESTABLISHED 1887

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Used and Rebuilt Metal-working Machines, Tools and Accessories

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Arranged so the buyer can see at a glance what selection, in the machines that interest him, is offered in the advertising pages following

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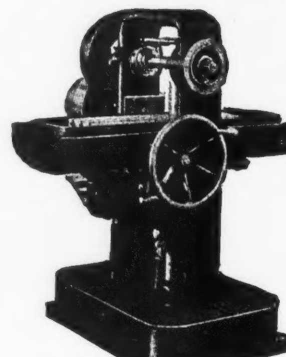

Type "A"

$175 each. F. O. B CARS NEW HAVEN CONN.

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SPECIFICATIONS

Table, Surface .... 24"x8"
Table, Traverse Feed .... 16"
3—⅝"—"T" Slots in Table.
Distance Between Housings ...... 12¼"
Cutter Space on Arbor .... 10"
Max. Dist. Table to Center of Arbor .. 12"
Arbor, No. 11 B. & S. Taper.
Spindle Driving Gear .... 14"x2"
Ratio of Gearing .... 4 to 1
Weight, about .... 2300 lbs.
Floor Space .... 42"x52"
8 Changes of Feed to Table

NOTE:—These machines are in the pink of condition, complete with countershafts, arbors, oil pumps, piping, wrenches, etc. Skidded and crated. May be inspected here at New Haven. "ACT QUICK."

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MUST VACATE PREMISES

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24″ x 10′ American Lathe.
26″ x 12′ Bridgeford Lathe.
24″ x 14′ Lodge & Shipley Lathe.
27″ x 26′ Schumacher & Boye Lathe.
42″ x 31′ Pond Lathe.
38″ x 50″ New Haven Lathe.
5′ Western Radial Drill.
4′, 5′, 6′ Prentice Radial Drills.
8-Spindle Bausch Multiple Drill, No. 3 Taper.
51″ N-B-P Vertical Boring Mills.
64″ Betts Vertical Boring Mills.
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Complete Pattern Shop.
Foundry Equipment.
5 to 75 H.P. D.C. Motors.
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Complete Vanstone Outfit.

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Compressor, 2500 cu. ft. A.C. motor.
Boring Mill, 12′ Pond, 2 heads.
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Hammers, No. 100 Bradley Horiz. Helve.
Hammers, No. 125 Bradley Upright Strap.
Hammers, Steam, S.E., Nos. 250, 600, 800, 1100.
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Lathe, 48″x24′ Bridgeford, G.H., M.D., A-1.
Lathe, 32″x14′ Draper, H.S., $600.
Lathe, 24″x10′ L. & S. Q.C.G., $400.
Miller, Vert. Becker, Model C.
Miller, Vert. Becker, No. 4, Rot. Table.
Pipe Machines, 8″ Saunders; 6″ Jarecki.
Planer, 26″x26″x8′ Niles, 1 head.
Press, 93-A Toledo, Dble. Crank, geared.
Press, 152 Bliss, Dble. Crank, Geared (2).
Punch, DE, 15″ thts., ¾″x¾″, arch. jaw.
Punch, SE, 30″ tht. ⅞″x⅞″, arch. jaw.
Shears, 37″x16 ga. Tol.; 42″x16 ga.

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Large Stock Shafting.
Leather and Rubber Belting.
Hangers and Pulleys.
Two 150 H.P. Fire Tube Boilers with Automatic Murphy Stoker.
Two Buckeye Engines.

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BELLEFONTAINE, OHIO

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2—Pulley Grinders, 24″ swing.
1—No. 5 Cin. Plain Milling Mach.
1—3-B K.&T. Plain Milling Mach.
1—No. 3 Cin. Vertical Milling Mach.
1—24″ Gisholt
1—No. 2 W. & S. Turret
3—6-A Potter & Johnson, each
1—5-A Potter & Johnson
1—36″ Becker & Brainard Miller
1—Espen Lucas Saw Grinder
1—Sellers Tool Grinder
1—No. 10 Brown & Sharpe Grinder
1—No. 4 Cincinnati
1—Cleveland Automatic, 2¾
1—18″ Becker & Brainard

GREENCASTLE PLANT

1—Putnam Planer, 24″x10′, one head on rail
1—Cleveland Boring, Milling and Drilling Machine, 2½″ bar
1—Fosdick 36″ Radial Drill
1—15″ Table Cin. Bickford Upright Drill
1—20″ Cin. Bickford Upright Drill with tapping attachment

GREENCASTLE PLANT—*Continued*

1—Kem. Vertical Drill, 24″ with tapping attachment
1—24″ Cin. Vertical Drill with tapping attachment
1—Sensitive Drill, ¾″ spindle
1—No. 3 Cin. Vertical Milling Mach.
1—Milwaukee 2½ Vertical (K. & T.)
1—Rockford Hand Miller
1—26″ McCabe Lathe
1—Morse Engine Lathe
1—16″x6′ American Lathe
1—16″x5′ Chord Lathe
1—18″x6′ Chord Lathe
1—24″ Gisholt
1—21″ Gisholt
1—21″ Gisholt
1—21″ Gisholt
1—24″ Gisholt
1—13″ Gisholt
1—J. & L. Flat Turret Lathe
1—Fellows Gear Shaper, 36″
1—Gould & Eberhardt 14″ Shaper
1—½ Becker-Brainard Milling Mach. with dividing head
1—Osterlein Tool Grinder

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Surplus Machine Tool Equipment, Steel Bars, Shafting, Grinding Wheels and Discs, etc. Write for particulars.

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All High Grade Machines, Fully Guaranteed

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4—24" Bullard Rapid Prod. Vert.	$1650
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42" Bullard Vertical, sgl. head	950
No. 1 Barnes Horizontal Boring Mill	450
Binsse Horizontal, table 30 x 40	1250

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42" Prentice Drill	400
4—21" Rockford 4 Spdl. Gang, each	600
Natco Semi-Automatic 6 spdl. Horiz.	450
2—No. 13 Pratt & Whitney 12 and 20 spindles, each	750
No. 22 Natco Multiple Drill	800
No. 37 Natco Multiple Drill	850
3' Fosdick Radial	575
2—3' Carleton Radial, each	375

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50" x 10 G. & E. Spur and Bevel	950
24" Fellows Gear Shaper	675
3—No. 3—26" B. & S. Spur, ea.	450
2—No. 4—36" B. & S. Spur, ea.	800

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2—No. 4 Greenerd Arbor Presses, each	110
No. 5 Farrel Open Back	150
No. 3 Baird, 1¾" str. brand new	390
2—No. 37½ Bliss Straight side, each	750
No. 1½ Bliss D.A. cam drawing	675
No. 62 Bliss, 5" stroke	275
2—No. 68 Bliss D.A. cam, each	500
No. 102-S Bliss, five plunger	1250
P-2 Ferracute 1½" stroke	350
2—No. 2 Billings & Spencer Trimming Presses, each	600
150 ton Nilson knuckle joint press	850
95 ton Watson-Stillman hydraulic presses, each	175

LATHES

Dalton B-6 Latest Type, chasing att.	225
4—9" x 14" Porter-Cable, each	300
12" x 9' Hendey M.D., comp., collets	700
14 x 8 Hendey Lathe	850
15 x 6 Monarch, quick change	475
14" x 10' Hendey, complete, collets	925
14" x 8' LeBlond Lathe	325
16" x 8' Hendey Lathe	775
16" x 8' Hendey Yoke Head, Equip.	1000
16" x 8' Lodge & Shipley	450
18 x 8 New Haven Engine, quick change	475
18 x 8 Cincinnati Severe Duty, Q.C., new	750
2—20" x 8' LeBlond quick change, ea.	600
20" x 10' American quick change	650
30" x 17' Pond Engine	750
32 x 12 Bridgeford Grd. Hd., 90% new	1750
32 x 18 New Haven, 99% new	1800

NUT AND BOLT TAPPERS

2—No. 5 Webster & Perks Vertical nut tappers, new, each	350
11—No. 4 Webster & Perks horiz. thread cutting and tapping machines, geared reversing type, each	350
No. 2 Garvin Automatic Tapper	225

PLANERS

16 x 16 x 48 Pratt & Whitney	275
24 x 24 x 6 Ohio	650
28 x 28 x 8 Flather	650
48 x 48 x 24 Pond	2500

SHAPERS

14" Hendey Friction	150
16" Hendey Friction, arranged for M.D.	250
16" Flather Crank Shaper	400
16" Kelly Crank Shaper	450

DIE SINKERS

3—Keller Automatic Die Sinkers, Type E3, price, each	650
2—No. 2 Pratt & Whitney, sq. base, ea.	600

Send for full particulars on those you are interested in. 1200 other machines in stock. What do you need?

J. L. LUCAS & SON Inc
LUCAS MACHINERY SERVICE
BRIDGEPORT, CONN.

SALE OF Surplus Machinery

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11—No. 4 W. & S.
8—No. 4 D. & W.
17—2½ Garvin.
4—3 x 36" J. & L.
1—2 x 24" J. & L.
1—1" Foster.
1—1½ Acme.

TURNING LATHES

4—14" x 6' Reed.
1—14" x 6' Pryibil.

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5—Norton Plain, various sizes.
4—Rivet Internal Grinders.
2—Cleveland Tool Grinders.
1—No. 11 B. & S. Plain Grinder.
1—No. 2 Morse Plain Grinder.
1—Surface Grinder with 3 heads.

AUTOMATICS

50—Cleveland 1¼" to 6¾".

MISCELLANEOUS

Hurlbut & Rogers Cut Off Machine.
Drill Presses. Profiler.
Planers. Filters. Blowers.

Standard Steel & Bearings Incorporated
Plainville, Conn.

BARGAINS IN USED MACHINERY

1—A-21-3½ Spindle Gisholt Turret Lathe.

1—No. 17 Foote-Burt Drill.

1—20" Style "A" Barnes 4-spindle Gang Drill.

2—16 x 7 Chard Lathes.

Lake Shore Machinery Co.
MUSKEGON, MICH.

Balancing Machine

OLSEN-CARWEN STATIC-DYNAMIC

Slightly Used

Corporation Appliance Co.
30 Church Street
NEW YORK

Real Values in Rebuilt Tools

No. 3A Brown & Sharpe Universal Miller, single pulley.
No. 4 R. K. LeBlond Univ. Miller, cone pul.
No. 3A Garvin Universal Miller, cone pulley.
No. 3B Brown & Sharpe Plain Miller, single pulley.
No. 3 Cincinnati High Power Plain miller, single pulley.
No. 3 Kempsmith Plain Miller, cone pulley.
No. 2B Brown & Sharpe Plain Miller, cone pulley.
No. 2 Cincinnati Plain Miller, cone pulley.
No. 1B Kearney & Trecker Plain Miller, single pulley.
No. 5 Becker Vertical Miller, cone pulley.
28" Cinti-Semi-Automatic Duplex Milling Machine.
36" x 22' Putnam Triple Geared Semi-quick change lathe.
30" x 17' Houston Stanwood & Gamble quick change lathe.
30" x 12' R. K. LeBlond quick change lathe.
24" x 10' R. K. LeBlond quick change lathe.
22" x 10' Hamilton semi-quick change lathe.
20" x 10' R. K. LeBlond quick change lathe.
20" x 8' Hendey Q.C. lathe, geared head.
18" x 8' Lodge & Shipley quick change lathe.
18" x 10' Greaves & Klusman Q.C. lathe.
16" x 8' Hendey Q.C. lathe with taper.
16" x 8' Hamilton quick change lathe.
14" x 6' Hendey tool-room lathe, quick change, with relieving and taper attach.
14" x 8' Hamilton tool-room lathe, quick change, with relieving taper and collet attachment.
3¼" x 36" Cinti-Acme Flat Turret Lathe, geared head.
24" Gisholt Turret Lathe with 5¼" hole in spindle.
No. 4 Brown & Sharpe Turret Screw Machine.
No. 4 Warner & Swasey Turret Screw Mach.
No. 2 S. P. Garvin Tur. Screw Mach. New.
No. 1 S. P. Garvin Tur. Screw Mach. New.
4' Niles Tool Wks. Univ. Radial Drill, M.Dr.
3½' Fosdick Plain Radial Drill, motor drive.
26" Rockford Upright Drill Press.
24" Kokomo Upright Drill Press with tapping attachments.
24" Milwaukee Upright Drill Press.
24" Cinti-Bickford Upright Drill gear box drive with tapping.
23" Rockford Upright Drill with tapping attachments.
20" W. F. & J. Barnes Upright Drill with tapping.
2 Spindle Leland & Gifford High Speed Ball Bearing Drill with power feed.
Sipp High Speed Ball Bearing quick change drill.
28" x 28" x 8' G. A. Gray Planer with two head.
24" Wm. Barker B.G. Crank Shaper. New.
20" Milwaukee Back Geared Crank Shaper.
16" Hamilton back geared crank shaper.
14" Pratt & Whitney Vert. Surface Grinder.
No. 2 Brown & Sharpe Auto. Surface Grinder, Magnetic Chuck.
No. 60 Heald Cylinder Grinder.
No. 1 Brown & Sharpe Universal Grinder.
6" x 18" Landis Plain Cylindrical Grinder.
No. 1½ Cinti Universal Tool and Cutter Grinder.
No. 2 Ohio Oesterlein Universal Tool and Cutter Grinder.
No. 2 Mitts & Merrill Keyseater, cap. to 1¼".
No. 3B J. N. LaPointe Broaching Machine, late type.
No. 1 Garvin Vert. Auto. Tap. Mch. New.
1½" Landis Bolt Cutter.
½" Acme Double Spindle Bolt Cutter.
No. 12 Barber-Colman Gear Hobber.
No. 12 Brown & Sharpe Auto. Spur and Bevel Gear Cutter.
24" Gould & Eberhardt Auto. Spur Gear Cutter.
8' Dries & Krump Power Brake, 12 gauge.
8' J. M. Robinson Hand Brake, 16 gauge.
50 lb. Bradley Rubber Cushioned Helve Hammer.
No. 4 Toledo Open Back Inclinable Power Press.
No. 85 Bliss Double Crank Straight Side Press.
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One Lot of Brand New Garvin Dividing Heads, sizes 10", 12" and 14".
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Lathes, Milling Machines, Drilling Machines, Etc.

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Used Machinery Department
ERIE, PA.

JONES' SPECIAL

No. 12 Barber-Colman Gear Hobber	$1150
24" S. & S. Gear Hobber	650
30" x 6' Gray Planer, 2 hds., M.D.	1350
No. 5 Niagara Press, o.b., inc.	375
No. 56 Stoll Press, geared type	600
No 3 Wilmarth Surface Grinder	600
12 x 72 Norton Grinder	800
16 x 60 Landis Crankshaft Grinder	850
14" G. & E. Shaper, b.g.	285
20" Hendy Geared Shaper	200

The Jones Machine Tool Co.
CINCINNATI, OHIO

FOR SALE Used Machinery In Good Condition

One—10" Two—12"
Four—14"
BROWN & SHARPE PLAIN CYLINDRICAL GRINDERS

Prices on Application

GILL MANUFACTURING CO.
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LATHES

12"x6' Seneca Falls, P.C.G.
14"x6' Seneca Falls, Q.C.G.
14"x6' Hendey Tool Room, Tie Bar.
14"x8' Whitcomb-Blaisdell, T.R., NEW.
17"x8' Sidney Lathe, Q.C.G., D.B.G.
18"x10' Lodge & Shipley, Q.C.G., S.P.D.
18"x10' Reed Q.C.G., D.B.G., H.S.
30"x12' Johnson Triple Geared.
30"x16' New Haven Screw Cutting.
34"x12' LeBlond Triple Geared, T.A.
36"x16' American Grd. Head, M.D.

PRESSES

No. 4 Toledo O.B.I. Press, 2½" Stroke.
No. 4 Loshbough-Jordan O.B.I. Press, 3" Str.
No. 5 Toledo O.B.I. Press, 3" Stroke.
No. 23 Stoll Horning Press.
DD-2 Ferracute Double Acting—25 Ton.
No. 52 Bliss Straight Sided Press.
No. 87 Niagara Screw Press.
Nos. 61 and 62 Bliss O.B. Flywheel Presses.
No. 65 Consolidated Grd. Press, 5" Stroke.
No. 74 Consolidated Geared, 2½" Stroke.
No. 305 Bliss S.S. Geared, Tie Rod, 8" Str.
No. 168 Toledo Toggle, Draw and Lift 12½".
No. 59 Toledo S.S., D.G., 12" stroke.

PUNCHES AND SHEARS

Reade S.E. Punch, ¾" x ¾", Arch. Jaw.
No. 61 Hendley & Whittemore, 30" Thr., Cap. ½"x¼".
No. 2 Quickwork, Capacity 14 Gauge.
No. 272 Niagara Squaring Shear, Cap. 14 Gauge.
96" Stoll Sq. Shear, 16 Gauge Cap.
96" Power Squaring Shear, 20 Gauge Cap.

MILLING MACHINES

No. 1 Steptoe with Dividing Head.
No. 1 United States Hand Miller.
No. 1 Knight Milling and Drilling Machine.
No. 2-A Brown & Sharpe Universal, S.P.D.
No. 29 Oesterlein Universal, V.A., M.D.
No. 2 Cincinnati Plain Miller, V.A.
No. 3 Hendey Plain Miller.
No. 2 Cincinnati H.P. Vert. Miller.
Model "B" Becker Vert. Miller, S.P.D.
Model "C" Becker Vert. Miller.

PLANERS AND SHAPERS

24"x24"x6' Gray Planer, 1 Head.
30"x30"x10' Woodward & Powell, 1 Head.
36"x36"x8' Cincinnati Planer, 1 Head.
72"x72"x18' Detrick & Harvey Openside.
20" Cincinnati Back Geared Crank Shaper.
20" Walcott B.G. Crank Shaper, S.P.D. NEW.
24" Springfield B.G. Crank Shaper.

SCREW MACHINES

Nos. 1 and 2 Warner & Swasey Screw Machines.
No. 6 Foster Screw Machine, G.F.H., P.F.

BORING MILLS

24" Bullard Rapid Production.
30" Bullard Vertical Boring Mill.
34" Colburn Vertical Boring Mill, 1 Head.
42" Bullard, 2 Swivel Heads, R.P.T.
42" King Vertical, 2 Heads, R.P.T. (2).
52" Bullard Maxi-Mills, R.P.T., S.P.D. (2).
72" Niles Vert. Boring Mill, 2 Hds., M.D.

DRILLING MACHINES

No. 1 Avey 3 Spindle, Belt Drive.
20" Barnes Camel Back Drill Press.
25" Weigel Sliding Head Drill Press.
25" Kern Sliding Head Drill Press.
No. 310 Baker Heavy Duty, No. 6 M.T.

MISCELLANEOUS

Nos. 1, 5 and 6 Williams & White Bulldozers.
16"x66" Landis Universal Grinder.
36"x10" G. & E. Gear Cutter, S.P.D.
60"x12" G. & E. Gear Cutter, S.P.D.
2" Acme Single Head Bolt Cutter.
3" Landis Single Head Bolt Cutter, L.S.
12" Merrill Pipe Machine, Cap. 2½" to 12".
3½" Stroke Garvin Die Slotter.
No. 1 Shuster Wire Straightener Sap. ¼" x 8'.
14" American Cut-off Saws, 5 H.P., A.C. Motor.
No. 8 Marvel Metal Band Saw.
60"x14 Ga. Dreis & Krump Power Brake, M.D.

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1407-09 BRIGHTON ROAD PITTSBURGH, PA.

H. F. ALLEN CO.

Incorporated
30 CHURCH ST. NEW YORK, N. Y.

14"x6' Hendey Lathe
16"x8' Greaves Klusman Lathe
32"x14' Fitchburg Lathe
24"x14' New Haven Lathe
1 spindle Sipp Ball Bearing Drill
2 spindle Allen Ball Bearing Drill
3 spindle Allen Ball Bearing Drill
36" Prentice Upright Drill, tapping attachment
No. 2 Brown & Sharpe Surface Grinder, magnetic chuck
No. 13 Brown & Sharpe Universal Grinder
24"x24"x6' New Powell Hy-Speed Planer 2 cross heads
27"x8' Flather Planer
No. 13 Williams & White Combination Punch & Shear
1½" Acme Bolt Cutter
No. 5 Foster Geared Head Turret Lathe
100,000 lbs. Tinius Olsen Testing Machine
No. 3 Brown & Sharpe Plain Miller
No. 4 Cincinnati Planer Miller, single pulley drive
F3 Turner Turret Drill

FOR SALE

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1—Root Blower

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8-25

MACHINERY'S Green Section, Date......................
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I should like particulars in regard to the following used machine tools:
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Name ....
Street ....
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Its Use

A good one for your driller, miller, shaper or planer.

The attachments mean that you can do much duplicate drilling without the cost of a jig.

Any vise will pay. More time is consumed in catching work than drilling it.

DRILL VISE

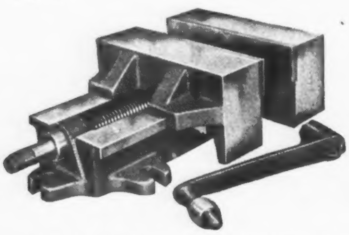


Fig. 2. Without Jig Attachments

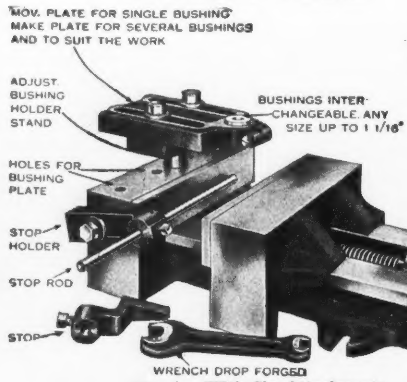


Fig. 1. With Jig Attachments

List Prices

No. 3, Jaws 6" long, with attachments, \$45.00, without \$40.00
No. 4, Jaws 9" long, with attachments, \$60.00, without \$54.00
No. 5, Jaws 12" long, with attachments, \$85.00, without \$75.00
V-Jaws extra, No. 3, \$5.00; No. 4, \$7.50; No. 5, \$10.00 each.
One V-Jaw is usually sufficient per vise.

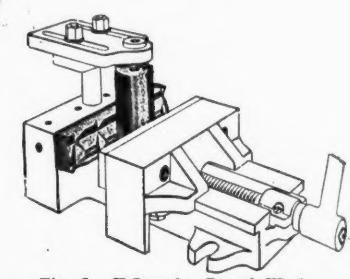


Fig. 3. V-Jaw for Round Work

THE GRAHAM MANUFACTURING COMPANY, 71 Willard Ave., Providence, R. I.

No Need of Jigs and Fixtures

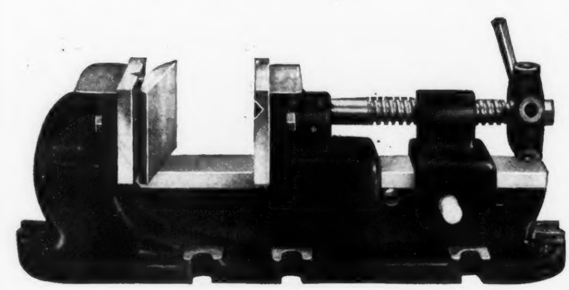
The Yost Drill Press will enable you to do away with many expensive jigs and fixtures. It is quick-acting and convenient, readily adapts itself to many pieces of odd-shaped work and its hold is positive. Jaws are gray iron, accurately machined; three flanges on base permit easy attachment to drill press table. A "V" shaped slot in movable jaw permits positive locking of vertical work.

Keep a Yost catalog handy—we'll send you one.

YOST MANUFACTURING COMPANY
MEADVILLE, PA.

YOST Drill Press Vise

The Gem Drill Press Vise



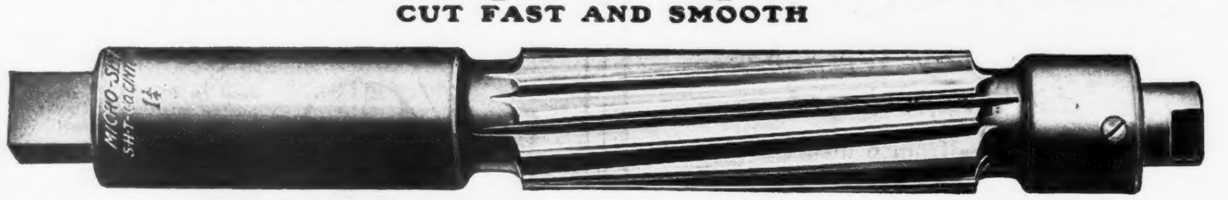
A SWIVEL jaw that automatically adjusts itself to work of any shape and *holds it rigidly* without special adjustment makes Gem Drill Press Vises time saving, money making equipment for drill press work.

Three sizes (largest opening to 10½"), each size with a range that makes it useful in any shop. Send for circular and prices.

J. E. MARTIN TOOL & DIE WORKS
548 West State Street, SPRINGFIELD, OHIO

The "Micro-Set" Expansion Spiral Hand Reamers

CUT FAST AND SMOOTH

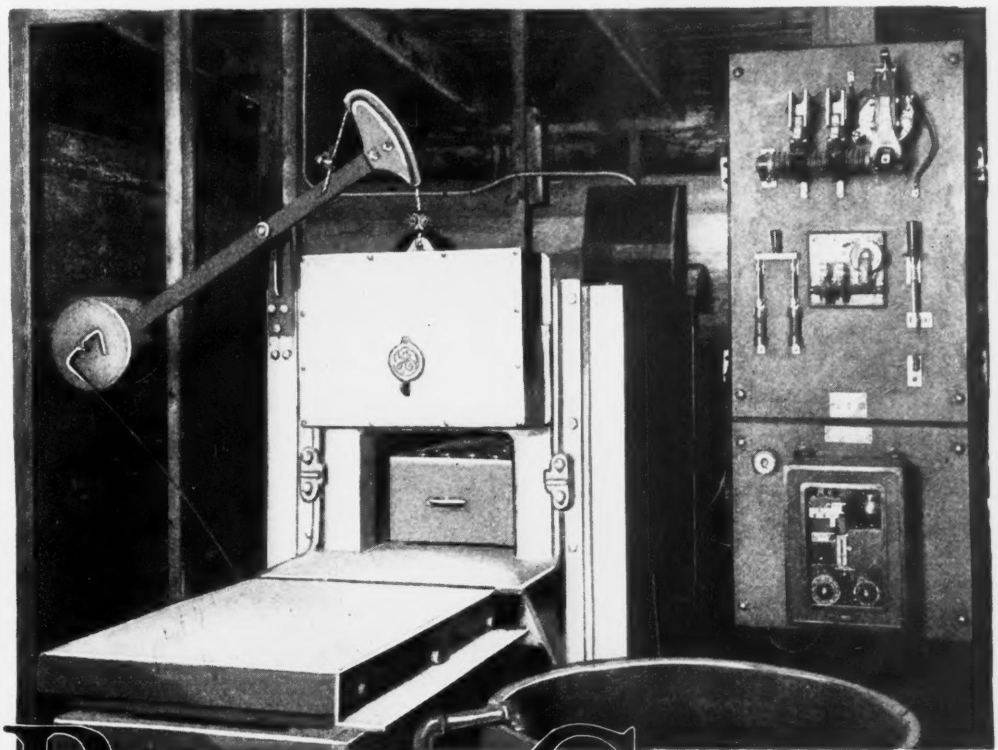


They have improved expanding features. The body of expanding screw fits closely into pilot and always maintains alignment. They are true after expanding. Micrometer dial on end of pilot gives readings in ¼ thousandths. Large range of expansion. They will ream true holes in keyseated or oil-grooved holes. Made in spiral or straight flutes and special lengths. All sizes can be shipped from stock.

THE SCHELLENBACH-HUNT TOOL CO., 116-124 Opera Place, Cincinnati, O.

F. E. Tighe Sales Company, 2953 Montgomery Avenue, Detroit, Mich.

H. E. Barton Tool Company, 104-106 South Jefferson St., Chicago, Ill.



MACHINERY'S PRODUCT INDEX

FOR LOCATION OF ADVERTISEMENTS OF MANUFACTURERS LISTED IN THIS INDEX SEE ALPHABETICAL INDEX, PAGES 283-284

ABRASIVE CLOTH AND PAPER
Carborundum Co., Niagara Falls, N. Y.

ACCUMULATORS, HYDRAULIC
Bethlehem Steel Co., Bethlehem, Pa.
Chambersburg Engineering Co., Chambersburg, Pa.
Elmes Eng. Works, Charles F., 222 North Morgan St., Chicago.
Farrel Fdry. & Mch. Co., Buffalo, N. Y.
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Philadelphia.
Watson-Stillman Co., 192 Fulton St., New York.

AIR HOISTS
See Hoists, Air.

ALLOYS, TUNGSTEN, URANIUM, VANADIUM, MOLYBDENUM, ALUMINUM, ETC.
Haynes Stellite Co., 30 E. 42nd St., New York.
Ludlum Steel Co., Watervliet, N. Y.
Vanadium Alloys Steel Co., Latrobe, Pa.

ANGLE PLATES, UNIVERSAL
Boston Scale & Mch. Co., Boston, Mass.

ANVILS
Yost Mfg. Co., Meadville, Pa.

ARBOR PRESSES
See Presses, Arbor.

ARBORS AND MANDRELS, EXPANDING
American Broach & Machine Co., Ann Arbor, Mich.
Cochrane-Bly Co., Rochester, N. Y.
Eastern Tube & Tool Corp., Brooklyn, N. Y.
McCrosky Tool Corp., Meadville, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Nicholson & Co., W. H., 112 Oregon St., Wilkes-Barre, Pa.
Western Tool & Mfg. Co., Springfield, Ohio.

ARBORS AND MANDRELS, SOLID
American Broach & Mch. Co., Ann Arbor, Mich.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland.
Greenfield Tap & Die Corp., Greenfield, Mass.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
National Tool Co., Cleveland.
National Twist Drill Tool Co., Detroit, Mich.
Nicholson & Co., W. H., 112 Oregon St., Wilkes-Barre, Pa.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland.
Union Twist Drill Co., Athol, Mass.

BABBITT
Ajax Metal Co., Philadelphia, Pa.
Besly & Co., Charles H., 120-B No. Clinton St., Chicago.
General Die-Casting Company, Reading, Pa.
Hoyt Metal Co., St. Louis, Mo.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

BALANCING EQUIPMENT
Anderson Bros. Mfg. Co., Rockford, Illinois.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Norton Co., Worcester, Mass.
Rockford Tool Co., Rockford, Ill.

BALLS, BRASS, STEEL, ETC.
Abbott Ball Co., Elmwood, Hartford, Conn.
Auburn Ball Bearing Co., 33 Elizabeth St., Rochester, N. Y.
Gwilliam Co., Brooklyn, N. Y.

BARS, BORING
See Boring Bars.

BARS, PHOSPHOR BRONZE
Bunting Brass & Bronze Co., Toledo, Ohio.

BEARINGS, BABBITT
Bunting Brass & Bronze Co., Toledo, Ohio.
Franklin Die-Casting Corp., Syracuse, N. Y.
General Die-Casting Company, Reading, Pa.
Hoyt Metal Co., St. Louis, Mo.
Link-Belt Company, Chicago.
Royersford Fdry. & Mch. Co., 54 N. 5th St., Philadelphia.
Wood's Sons Co., T. B., Chambersburg, Pa.

BEARINGS, BALL
Auburn Ball Bearing Co., 33 Elizabeth St., Rochester, N. Y.
Ball & Roller Bearing Co., Danbury, Conn.
Bantam Ball Bearing Co., Bantam, Ct.
Bearings Co. of America, Lancaster, Pa.
Boston Gear Wks. Sales Co., Norfolk Downs, Quincy, Mass.
Breakstone, S., 63 E. Harrison St., Chicago.
Ex-Cell-O Tool & Mfg. Co., Detroit.
Fafnir Bearing Co., New Britain, Conn.
Federal Bearings Co., Inc., Poughkeepsie, N. Y.
Gwilliam Co., Brooklyn, N. Y.
Marlin-Rockwell Corp., Jamestown, N. Y.
New Departure Mfg. Co., Bristol, Conn.
Norma-Hoffmann Bearings Corp., Stamford, Conn.
Schatz Mfg. Co., Poughkeepsie, N. Y.
Strom Ball Bearing Mfg. Co., 4563 Palmer St., Chicago.
Torrington Co., Torrington, Conn.

BEARINGS, BRONZE, AND SPECIAL ALLOYS
Ajax Metal Co., Philadelphia.
Besly & Co., Charles H., 12-B North Clinton St., Chicago.
Bunting Brass & Bronze Co., Toledo, Ohio.
Hoyt Metal Co., St. Louis, Mo.
Metal Sales Co., Jersey City, N. J.

BEARINGS, LINESHAFT
Adamson Mch. Co., Akron, O.
Hyatt Roller Bearing Co., Newark, N. J.
Roller Bearing Co. of America, Newark, N. J.
Royersord Fdry. & Mch. Co., 54 N. 5th St., Philadelphia.
Wood's Sons Co., T. B., Chambersburg, Pa.

BEARINGS, OILLESS
Arguto Oilless Bearings Co., 145 Berkley St., Wayne Junct'n, Philadelphia.

BEARINGS, ROLLER
Ball & Roller Bearing Co., Danbury, Conn.
Bantam Ball Bearing Co., Bantam, Ct.
Bond, Charles Co., Philadelphia.
Breakstone, S., 63 E. Harrison St., Chicago.
Gwilliam Co., Brooklyn, N. Y.
Hyatt Roller Bearing Co., Newark, N. J.
Norma-Hoffmann Bearings Corp., Stamford, Conn.
Roller Bearing Co. of America, Newark, N. J.
Royersford Fdry. & Mch. Co., 54 N. 5th St., Philadelphia.
Timken Roller Bearing Co., Canton, Ohio.

BEARINGS, SELF-OILING
Link-Belt Company, Chicago.
Wood's Sons Co., T. B., Chambersburg, Pa.

BEARINGS, TAPERED ROLLER
Timken Roller Bearing Co., Canton, O.

BEARINGS, THRUST
Auburn Ball Bearing Co., 33 Elizabeth St., Rochester, N. Y.
Bantam Ball Bearing Co., Bantam, Ct.
Bearings Co. of America, Lancaster, Pa.
Breakstone, S., 63 E. Harrison St., Chicago.
General Electric Co., Schenectady, N. Y.
Gwilliam Co., Brooklyn, N. Y.
Norma-Hoffmann Bearings Corp., Stamford, Conn.
Timken Roller Bearing Co., Canton, O.

BELT CEMENT
Chicago Belting Co., 127 N. Green St., Chicago, Ill.
Chicago Rawhide Mfg. Co., 1309 Elston Ave., Chicago.
Schieren Co., Chas. A., 73 Ferry St., New York.

BELT CLAMPS
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Wood's Sons Co., T. B., Chambersburg, Pa.

BELT DRESSING
Atkins & Co., Inc., E. C., Indianapolis, Ind.
Chicago Belting Co., 127 N. Green St., Chicago, Ill.
Chicago Rawhide Mfg. Co., 1309 Elston Ave., Chicago.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Schieren Co., Chas. A., 73 Ferry St., New York.

BELT FASTENERS, LEATHER
Chicago Belting Co., 127 N. Green St., Chicago, Ill.
Chicago Rawhide Mfg. Co., 1309 Elston Ave., Chicago.
Schieren Co., Chas. A., 73 Ferry St., New York.

BELT FASTENERS, METAL
Bristol Co., Waterbury, Conn.
Chicago Belting Co., 127 N. Green St., Chicago, Ill.
Greene, Tweed & Co., 109 Duane St., New York.
Schieren Co., Chas. A., 73 Ferry St., New York.

BELTING, LEATHER
Chicago Belting Co., 127 N. Green St., Chicago, Ill.
Chicago Rawhide Mfg. Co., 1309 Elston Ave., Chicago.
Schieren Co., Chas. A., 73 Ferry St., New York.

BELTING, ROUND LEATHER
Chicago Belting Co., 127 N. Green St., Chicago, Ill.
Chicago Rawhide Mfg. Co., 1309 Elston Ave., Chicago.
Schieren Co., Chas. A., 73 Ferry St., New York.
Western Rawhide & Belting Co., Milwaukee, Wis.

BELT LACING
Chicago Belting Co., 127 N. Green St., Chicago, Ill.
Chicago Rawhide Mfg. Co., 1309 Elston Ave., Chicago.
Schieren Co., Chas. A., 73 Ferry St., New York.
Western Rawhide & Belting Co., Milwaukee, Wis.

BELT SHIFTERS
Haskins Company, R. G., 520 W. Monroe St., Chicago, Ill.
Kremer-Cummins Mch. Co., Cleveland.
LeBlond, R. K., Machine Tool Co., Cincinnati.
Ready Tool Co., Bridgeport, Conn.
Wood's Sons Co., T. B., Chambersburg, Pa.

BENCH LEGS
Angle Steel Stool Co., Plainwell, Mich.
Brown & Sharpe Mfg. Co., Providence, R. I.
Standard Pressed Steel Co., Jenkintown, Pa.

BENDING MACHINES, ANGLE IRON
Buffalo Forge Co., Buffalo, N. Y.
Wickes Bros., Saginaw, Mich.

BENDING MACHINES, HYDRAULIC
Bethlehem Steel Co., Bethlehem, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Watson-Stillman Co., 192 Fulton St., New York.
Williams, White & Co., Moline, Ill.

BENDING MACHINES, PIPE
Buffalo Forge Co., Buffalo, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia.
Sellers & Co., Inc., Wm., Philadelphia.
Underwood Corp., H. B., Philadelphia.
Watson-Stillman Co., 192 Fulton St., New York.

BLOCKS, CHAIN
See Hoists, etc.

BLOWERS
American Gas Furnace Co., Elizabeth, N. J.
Buffalo Forge Co., Buffalo, N. Y.
Canedy-Otto Mfg. Co., Chicago Heights, Ill.
Chicago Flexible Shaft Co., 1154 S. Central Ave., Chicago.
General Electric Co., Schenectady, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

BLOWERS, POSITIVE PRESSURE
American Gas Furnace Co., Elizabeth, N. J.
Chicago Flexible Shaft Co., 1154 S. Central Ave., Chicago.
Leiman Bros., 60-62 Lispenard St., New York.

BLUEPRINT DRYING MACHINES
Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Keuffel & Esser Co., Hoboken, N. J.
Paragon Machine Co., Rochester, N. Y.

BLUEPRINT FILING CABINETS
See Cabinets, Filing.

BLUEPRINT MACHINES
Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Keuffel & Esser Co., Hoboken, N. J.
Paragon Machine Co., Rochester, N. Y.
Wickes Bros., Saginaw, Mich.

BLUEPRINT PAPER
Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Keuffel & Esser Co., Hoboken, N. J.
Paragon Machine Co., Rochester, N. Y.

BLUEPRINTING
Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.

BOILER TUBES
National Tube Co., Pittsburgh, Pa.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.

BOLT AND NUT MACHINERY
Acme Machinery Co., Cleveland.
Ajax Mfg. Co., Cleveland.
Economy Engineering Co., Willoughby, Ohio.
Landis Machine Co., Inc., Waynesboro, Pa.
National Acme Co., Cleveland, O.

BOLTS AND NUTS
National Machinery Co., Tiffin, O.
National Acme Co., Cleveland, O.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.

BOOKS, TECHNICAL
Industrial Press, 145 Lafayette St., New York.

BOOSTERS
American Gas Furnace Co., Elizabeth, N. J.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

BORING AND DRILLING MACHINES, VERTICAL
Baker Bros., Inc., Toledo, O.
Barnes Drill Co., 814 Chestnut St., Rockford, Ill.
Bullard Machine Tool Co., Bridgeport, Conn.
Cochrane-Bly Co., Rochester, N. Y.
Colburn Mch. Tool Co., Rochester.
Consolidated Machine Tool Corp., Rochester, N. Y.
Ferner Co., R. Y., Washington, D. C.
Foote-Burt Co., Cleveland.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Ingersoll Milling Mch. Co., Rockford, Ill.
Moline Tool Co., Moline, Ill.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Philadelphia.

BORING AND TURNING MILLS, VERTICAL
Betts Machine Co., Rochester, N. Y.
Bullard Machine Tool Co., Bridgeport, Conn.
Cincinnati Planer Co., Cincinnati.
Colburn Mch. Tool Co., Rochester.
Consolidated Machine Tool Corp., Rochester, N. Y.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Niles-Bement-Pond Co., 111 Broadway, N. Y.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Sellers & Co., Inc., Wm., Philadelphia.

BORING BARS
American Hollow Boring Co., Erie, Pa.
Armstrong Bros. Tool Co., 313 No. Francisco Ave., Chicago.
Bullard Machine Tool Co., Bridgeport, Conn.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Lovejoy Tool Co., Inc., Springfield, Vt.
Madison Mfg. Co., Muskegon, Mich.
Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia.
Production Engineering Corp., Canastota, N. Y.
Ready Tool Co., Bridgeport, Conn.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Underwood Corp., H. B., Philadelphia.
Williams, J. H., & Co., Buffalo, N. Y.

BORING, DRILLING AND MILLING MACHINES, HORIZONTAL
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Bethlehem Steel Co., Bethlehem, Pa.
Betts Machine Co., Rochester, N. Y.
Consolidated Mch. Tool Corp. of America, Rochester, N. Y.
Giddings & Lewis Mch. Tool Co., Fond du Lac, Wis.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Hoefer Mfg. Co., Freeport, Ill.
Ingersoll Milling Mch. Co., Rockford, Ill.
Landis Tool Co., Waynesboro, Pa.
Lucas Mch. Tool Co., Cleveland.
Newton Machine Tool Works, Inc., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pedrick Tool & Mch. Co., 3639 No. Lawrence St., Philadelphia.
Rockford Drilling Machine Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia.
Summer & Adams Co., Cleveland.
Universal Boring Mch. Co., Hudson, Mass.
Wetzel, Karl, Gera-R., Germany.

BORING HEADS, OFFSET
Gairing Tool Co., Inc., Detroit.
Porter-Cable Machine Co., Syracuse, N. Y.
Production Engineering Corp., Canastota, N. Y.

BORING TOOLS
American Hollow Boring Co., Erie, Pa.
Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago.
Gairing Tool Co., Inc., Detroit.
Lovejoy Tool Co., Inc., Springfield, Vt.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
O. K. Tool Co., Inc., Shelton, Conn.
Ready Tool Co., Bridgeport, Conn.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams, J. H., & Co., Buffalo, N. Y.

BOXES, CARBONIZING
Driver-Harris Co., Harrison, N. J.
Farrell-Cheek Steel Fdry. Co., Sandusky, O.

BRAKES, PRESS AND BENDING
Cincinnati Shaper Co., Cincinnati.
Loy & Nawrath. Div. Birmingham Iron Foundry, Derby, Conn.
Stoll Co., Inc., D. H., Buffalo, N. Y.

BRASS AND COPPER RODS, SHEETS, TUBES
Bridgeport Brass Co., Bridgeport, Conn.

BRAZING EQUIPMENT
Amerian Gas Furnace Co., Elizabeth, N. J.
Chicago Flexible Shaft Co., 1154 S. Central Ave., Chicago.

BROACHES
American Broach & Machine Co., Ann Arbor, Mich.
Lapointe Co., J. N., New London, Conn.
Lapointe Mch. Tool Co., Hudson, Mass.
Oilgear Co., Milwaukee, Wis.
Taft-Peirce Mfg. Co., Woonsocket, R. I.

BROACH GRINDING MACHINES
Lapointe Co., J. N., New London, Ct.

BROACHING MACHINES
American Broach & Machine Co., Ann Arbor, Mich.
Lapointe Co., J. N., New London, Ct.
Lapointe Machine Tool Co., Hudson, Mass.
Oilgear Co., Milwaukee, Wis.
Toledo Mch. & Tool Co., Toledo.
V & O Press Co., Hudson, N. Y.

BROACHING PRESS, HAND
American Broach & Machine Co., Ann Arbor, Mich.

BRONZE
Ajax Metal Co., Philadelphia.
Bunting Brass & Bronze Co., Toledo, Ohio.

BRONZE WIRE, RODS AND SHEETS
Bridgeport Brass Co., Bridgeport, Conn.

BUFFERS
Bridgeport Safety Emery Wheel Co., Inc., 1283 W. Broad St., Bridgeport, Conn.
Builders Iron Foundry, Providence, R. I.
Chicago Flexible Shaft Co., 1154 S. Central Ave., Chicago.
Cincinnati Electrical Tool Co., Cincinnati.
Gardner Mch. Co., 414 E. Gardner St., Beloit, Wis.
Marschke Mfg. Co., Indianapolis, Ind.
Neil & Smith Electric Tool Co., Cincinnati.
Stow Mfg. Co., Binghamton, N. Y.

BUFFING MACHINES, AUTOMATIC
Automatic Buffing Mch. Co., Buffalo, N. Y.

BULLDOZERS
Ajax Mfg. Co., Cleveland.
Bliss Co., E. W. Brooklyn, N. Y.
National Machinery Co., Tiffin, O.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Watson-Stillman Co., 192 Fulton St., New York.
Williams, White & Co., Moline, Ill.

BURNERS, GAS AND OIL
Chicago Flexible Shaft Co., 1154 S. Central Ave., Chicago.
Surface Combustion Co., 363 Gerard Ave., New York.

BURNISHING MACHINERY
Abbott Ball Co., Elmwood, Hartford, Conn.
Baird Machine Co., Bridgeport, Conn.
Globe Mch. & Stamping Co., 1225 W. 76th St., Cleveland, O.

BURRING MACHINES, FORGING
Ajax Mfg. Co., Cleveland, O.

BUSHINGS, BRASS, BRONZE, ETC.
Bridgeport Brass Co., Bridgeport, Conn.
Brown Engineering Co., 133 No. 3rd St., Reading, Pa.
Bunting Brass & Bronze Co., Toledo, Ohio.
Wilmington Fibre Specialty Co., Wilmington, Del.

BUSHINGS, HARDENED
Danly Machine Specialties, Inc., 4907 Lincoln Ave., Chicago.

BUSHINGS, JIG
Ex-Cell-O Tool & Mfg. Co., Detroit.

CABINETS, FILING
Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Keuffel & Esser Co., Hoboken, N. J.
Paragon Machine Co., Rochester, N. Y.

CABINETS, TOOL
Angle Steel Stool Co., Plainwell, Mich.
Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago.
Gerstner & Sons, H., Dayton, O.
Morse Twist Drill & Mch. Co., New Bedford, Mass.

CALIPER GAGES
Williams, J. H., & Co., Buffalo, N. Y.

CALIPERS
Brown & Sharpe Mfg. Co., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

CAMS
Rowbottom Mch. Co., Waterbury, Ct.

CASE-HARDENING
American Gas Furnace Co., Elizabeth, N. J.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston 25, Mass.
Pittsburgh Gear & Mch. Co., 2700 Smallman St., Pittsburgh.
Williams, J. H., & Co., Buffalo, N. Y.

CASE-HARDENING FURNACES
See Furnaces, Case-hardening.

CASTINGS, BRASS, BRONZE AND ALUMINUM
Ajax Metal Co., Philadelphia.
Bunting Brass & Bronze Co., Toledo.

CASTINGS, DIE OR DIE MOLDED
Alemite Die-Casting Mfg. Co., 2640-54 Belmont Ave., Chicago.
Franklin Die-Casting Corp., Syracuse, N. Y.
General Die-Casting Company, Reading, Pa.
Hoyt Metal Co., St. Louis, Mo.
Latrobe & Die & Casting Co., Latrobe, Pa.
McGill Metal Co., Valparaiso, Ind.
National Lead Co., 111 Broadway, New York.
Republic Die Casting Co., Inc., 128E Mott St., New York.
Sterling Die-Casting Co., Inc., Brooklyn, N. Y.
Superior Die-Casting Co., Cleveland.
Twin City Die Casting Co., Minneapolis, Minn.
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

CASTINGS, DIE OR DIE MOLDED ALUMINUM
Alemite Die-Casting & Mfg. Co., 2640-54 Belmont Ave., Chicago.
Franklin Die-Casting Corp., Syracuse, N. Y.
General Die-Casting Company, Reading, Pa.
National Lead Co., 111 Broadway, New York.
Phoenix Die Casting Corp., Buffalo.
Republic Die Casting Co., Inc., 128E Mott St., New York.
Sterling Die Casting Co., Inc., Brooklyn, N. Y.
Superior Die-Casting Co., Cleveland.
Twin City Die Casting Co., Minneapolis, Minn.

CASTINGS, GRAY IRON
Brown & Sharpe Mfg. Co., Providence, R. I.
Chambersburg Engineering Co., Chambersburg, Pa.
Reed-Prentice Co., Worcester, Mass.
Sweet & Doyle Fdry. & Mch. Co., Troy, Green Island, N. Y.
Toledo Mch. & Tool Co., Toledo, O.

CASTINGS, MALLEABLE
Link-Belt Company, Chicago.

CASTINGS, NICHROME
Driver-Harris Co., Harrison, N. J.

CASTINGS, STEEL
Falk Corp., Milwaukee, Wis.
Farrell-Cheek Steel Foundry Co., Sandusky, O.

CEMENT, DISC GRINDING WHEEL
Badger Tool Co., Beloit, Wis.
Besly & Co., Chas. H., 120-B N. Clinton St., Chicago.
Gardner Machine Co., 414 E. Gardner St., Beloit, Wis.
Walls Sales Corp., 96 Warren St., New York.

CENTERING MACHINES
Consolidated Machine Tool Corp., Rochester, N. Y.
Hanson-Whitney Machine Co., Hartford, Conn.
Hendey Mch. Co., Torrington, Conn.
Newton Machine Tool Works, Inc., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pratt & Whitney Co., Hartford, Conn.
Whiton Mach. Co., D. E., New London, Conn.

CENTERS, LATHE
Haynes Stellite Co., 30 E. 42nd St., New York.

CENTERS, PLANER AND MILLER
Cincinnati Planer Co., Cincinnati
Morse Twist Drill & Mch. Co., New Bedford, Mass.

CHAIN BLOCKS
See Hoists, Chain, etc.

CHAINS, POWER TRANSMISSION
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Wks. Sales Co., Norfolk, Downs, Quincy, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Company, Chicago.
Morse Chain Co., Ithaca, N. Y.
Ramsey Chain Co., Inc., Albany, N. Y.
Whitney Mfg. Co., Hartford, Conn.

CHECKS, TIME, TOOL AND PAY
Noble & Westbrook Mfg. Co., Hartford, Conn.
Schwerdte Stamp Co., Bridgeport, Ct.

CHISEL BLANKS, PNEUMATIC HAMMER
Chicago Pneumatic Tool Co., 6 E. 44th St., New York.
Hunter Saw & Mch. Co., Pittsburgh.
Ingersoll-Rand Co., 11 Broadway, New York.

CHISELS, PNEUMATIC HAMMER
Chicago Pneumatic Tool Co., 6 E. 44th St., New York.
Ingersoll-Rand Co., 11 Broadway, New York.

CHUCKING MACHINES, AUTOMATIC
Baird Machine Co., Bridgeport, Conn.
Bullard Machine Tool Co., Bridgeport, Conn.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Goss & DeLeeuw Machine Co., New Britain, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Potter & Johnston Machine Co., Pawtucket, R. I.

CHUCKING MACHINES, SEMI-AUTOMATIC
Bardons & Oliver, Cleveland.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bullard Machine Tool Co., Bridgeport, Conn.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Jones & Lamson Machine Co., Springfield, Vt.
National Acme Co., Cleveland, O.

CHUCKS, AIR OPERATED
Frontier Chuck & Tool Co., Buffalo, N. Y.
Logansport Machine Co., 529 Market St., Logansport, Ind.

CHUCKS, COLLET OR SPLIT
Ames Co., B. C., Waltham, Mass.
Rivett Lathe & Grinder Corp., Brighton, Boston.
Stark Tool Co., Waltham, Mass.
Wade Tool Co., Waltham, Mass.
Whitney Mfg. Co., Hartford, Conn.

CHUCKS, DRILL
Boker, H., & Co., Inc., 103 Duane St., New York.
Cleveland Twist Drill Co., Cleveland.
Consolidated Machine Tool Corp., Rochester, N. Y.
Cushman Chuck Co., Hartford, Conn.
Eastern Tube & Tool Co., Inc., Brooklyn, N. Y.
Jacobs Mfg. Co. Hartford Conn.
McCrosky Tool Corp., Meadville, Pa.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
National Twist Drill & Tool Co., Detroit, Mich.
Production Engineering Corp., Canastota, N. Y.
Scully-Jones Co., 13th and Robey Sts., Chicago.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland.
Union Mfg. Co., New Britain, Conn.
Watts Bros. Tool Works, Wilmerding, Pa.
Westcott Chuck Co., Oneida, N. Y.
Whitney Mfg. Co., Hartford, Conn.
Whiton Machine Co., D. E. New London, Conn.

CHUCKS, ECCENTRIC BORING
Production Engineering Corp., Canastota, N. Y.

CHUCKS, FULL FLOATING
Errington Mechanical Laboratory, Broadway and John St., New York.
Watts Bros. Tool Works, Wilmerding, Pa.

CHUCKS, GEAR
Garrison Gear Grinder Co., Dayton, O.
Garrison Machine Works, Dayton, O.

CHUCKS, LATHE, ETC.
Bullard Machine Tool Co., Bridgeport, Conn.
Cushman Chuck Co., Hartford, Conn.
Foster Machine Co., Elkhart, Ind.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
McCrosky Tool Corp., Meadville, Pa.
Rivett Lathe & Grinder Corp., Brighton District, Boston.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Skinner Chuck Co., New Britain, Conn.
Thomas Elevator Co., 24 So. Hoyne Ave., Chicago.
Union Mfg. Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mch. Co., D. E., New London, Conn.

CHUCKS, MAGNETIC
Heald Mch. Co., 16 New Bond St., Worcester, Mass.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Walker Company, Inc., O. S., Worcester, Mass.

CHUCKS, PLANER
Cincinnati Planer Co., Cincinnati, O.
Cushman Chuck Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Conn.

CHUCKS, QUICK CHANGE AND SAFETY
Errington Mechanical Laboratory, Broadway and John St., New York.
Geometric Tool Co., New Haven, Ct.
McCrosky Tool Corp., Meadville, Pa.
National Tool Co., Cleveland.
Whitney Mfg. Co., Hartford, Conn.

CHUCKS, RING WHEEL
Gardner Mch. Co., 414 E. Garden St., Beloit, Wis.

CHUCKS, TAPPING
Barber-Colman Co., Rockford, Ill.
Errington Mechanical Laboratory, Broadway and John St., New York.
McCrosky Tool Corp., Meadville, Pa.
Procunier, Wm. L., 18 South Clinton St., Chicago.
Scully-Jones & Co., 13th and Robey Sts., Chicago.
Watts Bros. Tool Works, Wilmerding, Pa.
Whitney Mfg. Co., Hartford, Conn.

CHUCKS, VACUUM
Chicago Pneumatic Tool Co., 6 E. 44th St., New Yrok.

CIRCUIT BREAKERS
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

CLAMPS
Armstrong Bros. Tool Co., 313 No. Francisco Ave., Chicago.
Besly & Co., Charles H., 120-B No. Clinton St., Chicago.
Brown & Sharpe Mfg. Co., Providence, R. I.
Danly Machine Specialties, Inc., 4907 Lincoln Ave., Chicago.
Starrett Co., L. S., Athol, Mass.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams, J. H., & Co., Buffalo, N. Y.

CLEANSERS, CHEMICAL, FOR WASTE AND METAL
Oakley Chemical Co., 26 Thames St., New York.

CLEANING COMPOUND
See Compound, Cleaning.

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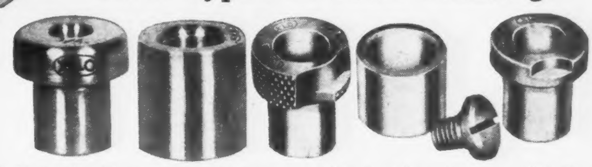
Five Types of XLO Bushings



1. Head bushing, press fit type. 3. Slip bushing, for use with liner.
2. Headless bushing, press fit type. 4. Liner bushing.
5. Plain bushing for use with liner.

JUST a short time ago, jig bushings were a sadly neglected part of production drilling equipment. Requirements were almost entirely filled in a make-shift sort of way by bushings made at the last minute in the user's own plant. This took time—and cost money.

Now, however, quantity production of jig bushings has been so highly specialized by the Ex-Cell-O Company that jig bushings far superior in quality and accuracy are available at a fraction of the cost of the "home-made" product! That's a broad statement, perhaps—but put it to the test!

Let us send you a set of XLO Data Sheets for your files. They give **2534** standard sizes, with prices. You know the advantages of **standardizing**—you'll see the economy of specifying XLO!

We will exhibit at National Steel Exposition, Cleveland, O., Sept. 14-18

EX-CELL-O TOOL & MANUFACTURING CO.

High Speed Grinding Spindles — XLO — ***Drill Jig Bushings***

1469 E. GRAND BOULEVARD **DETROIT, MICHIGAN**

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Farrel Fdry. & Mch. Co., Buffalo, N. Y.
Hilliard Clutch & Mch. Co., Elmira, N. Y.
Johnson Machine Co., Carlyle, Manchester, Conn.
Jones Foundry & Machine Co., W. A., 4409 W. Roosevelt Rd., Chicago.
Link-Belt Company, Chicago.
Moore & White Co., 2707-2737 No. 15th St., Philadelphia.
Production Machine Co., Greenfield, Mass.
Twin Disc Clutch Co., Racine, Wis.
Williams Fdry. & Mch. Co., Akron, O.
Wood's Sons Co., T. B., Chambersburg, Pa.

COLLARS, SAFETY

Bond, Charles Co., Philadelphia.
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Brown Co., A. & F., 79 Barclay St., New York.
Link-Belt Company, Chicago.
Royersford Fdry. & Mch. Co., 54 N. 5th St., Philadelphia.
Standard Pressed Steel Co., Jenkintown, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

COLLARS, SPACING, ETC.

Detroit Stamping Co., Detroit, Mich.
Scully-Jones Co., 13th and Robey Sts., Chicago.

COLLETS

Cleveland Twist Drill Co., Cleveland.
Geometric Tool Co., New Haven, Conn.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.

COLLETS, SPRING

Ames Co., B. C., Waltham, Mass.
Rivet Lathe & Grinder Corp., Brighton, Boston.
Whitney Mfg. Co., Hartford, Conn.
Stark Tool Co., Waltham, Mass.

COMMUTATORS

General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

COMPARATOR, SCREW THREAD

Bausch & Lomb Optical Co., Rochester, N. Y.
Ferner Co., R. Y., Washington, D. C.
Jones & Lamson Mch. Co., Springfield, Vermont.

COMPOUND, CLEANING

Oakley Chemical Co., 26 Thames St., New York.

COMPOUND, CUTTING, GRINDING, ETC.

Oakley Chemical Co., 26 Thames St., New York.
Pep Mfg. Co., Inc., 33 W. 42nd St., New York.
Sun Oil Company, Philadelphia.

COMPRESSORS, AIR AND GAS

Chicago Pneumatic Tool Co., 6 E. 44th St., New York.
General Electric Co., Schenectady, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York.

CONDUITS

Eastern Tube & Tool Co., Inc., Brooklyn, N. Y.

CONNECTORS, FRANKEL, SOLDERLESS

Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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Active Machine & Tool Co., Cleveland.
Adamson Mch. Co., Akron, O.
American Tool & Mfg. Co., Urbana, O.
Banner Die, Tool & Stamping Co., Columbus, O.
Bliss Co., E. W., Brooklyn, N. Y.
Brock Tool & Mfg. Works, Arthur, Jr., Philadelphia.
Brown & Sharpe Mfg. Co., Providence, R. I.
Columbus Die, Tool & Mch. Co., Columbus, O.
Diefendorf Gear Corp., Syracuse, N. Y.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Globe Machine & Stamping Co., 1255 W. 76th St., Cleveland, O.
Hanna Engineering Works, 1763 Elston Ave., Chicago.
Hoefer Mfg. Co., Freeport, Ill.
Kent-Owens Mch. Co., Toledo, O.
Kremmer-Cummins Co., Cleveland.
Langelier Mfg. Co., Arlington, Cranston, R. I.
LeBlond, R. K., Machine Tool Co., Cincinnati.
Lees-Bradner Co., Cleveland.
Mehl Mch. Tool & Die Co., Roselle, N. J.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston 25, Mass.
Mummert-Dixon Co., Hanover, Pa.
Nicholson & Co., W. H., 112 Oregon St., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pennsylvania Tool & Mfg. Co., York, Pa.
Pratt & Whitney Co., Hartford, Conn.
Production Engineering Corp., Canastota, N. Y.
Reliance Die & Stamping Co., 515 No. LaSalle St., Chicago.
Ruthman Machinery Co., Cincinnati.
Smalley-General Co., Inc., Bay City, Mich.
Steel Products Engineering Co., Springfield, Ohio.
Sweet & Doyle Fdry. & Mch. Co., Troy, Green Island, N. Y.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Taylor & Fenn Co., Hartford, Conn.
Taylor-Shantz Co., Rochester, N. Y.
U. S. Tool Co., Inc., Ampere, N. J.
V & O Press Co., Hudson, N. Y.
Wade Tool Co., Waltham, Mass.
Wappat Gear Wks., Pittsburgh, Pa.
Wicaco Screw & Mch. Works, Inc., Philadelphia.

CONTROLLERS

American Gas Furnace Co., Elizabeth, N. J.
General Electric Co., Schenectady, N. Y.
Monitor Controller Co., Baltimore, Md.
Reliance Electric & Eng. Co., 1056 Ivanhoe Road, Cleveland.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

CONVEYORS, BELT

Link-Belt Company, Chicago.

CONVEYORS, GRAVITY

Link-Belt Company, Chicago.

COTTER PINS

Williams, J. H., & Co., Buffalo, N. Y

COUNTERBORERS

Cleveland Twist Drill Co., Cleveland.
Gairing Tool Co., Inc., Detroit.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
National Tool Co., Cleveland.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland.
Starrett Co., L. S., Athol, Mass.
Threadwell Tool Co., Greenfield, Mass.
Union Twist Drill Co., Athol, Mass.

COUNTERSHAFTS, FRICTION, ETC.

Bardons & Oliver, Cleveland.
Brown Co., A. & F., 79 Barclay St., New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders Iron Fdry., Providence, R. I.
Diamond Mch. Co., Providence, R. I.
Edgemont Mch. Co., Dayton, O.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Hilliard Clutch & Machinery Co., Elmira, N. Y.
Jones Foundry & Mch. Co., W. A., 4409 W. Roosevelt Rd., Chicago.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Warner & Swasey Co., Cleveland.
Wood's Sons Co., T. B., Chambersburg, Pa.

COUNTERSINKS

Cogsdill Mfg. Co., Detroit.
Gairing Tool Co., Inc., Detroit.
Greenfield Tap & Die Corp., Greenfield, Mass.

COUNTERS, REVOLUTION

Bristol Co., Waterbury, Conn.
Root Co., Bristol, Conn.
Starrett Co., L. S., Athol, Mass.
Veeder Mfg. Co., 39 Sargeant St., Hartford, Mass.

COUPLERS, HOSE

Chicago Pneumatic Tool Co., 6 E. 44th St., New York.
Greene, Tweed & Co., 109 Duane St., New York.
Ingersoll-Rand Co., 11 Broadway, New York.

COUPLINGS, CUT-OFF, FRICTION

Conway Clutch Co., Cincinnati, O.
Edgemont Machine Co., Dayton, O.
Johnson Machine Co., Carlyle, Manchester, Conn.
Wood's Sons Co., T. B., Chambersburg, Pa.

COUPLINGS, FLEXIBLE SHAFT

Bond, Charles Co., Philadelphia.
Boston Gear Wks. Sales Co., Norfolk Downs, Quincy, Mass.
Brown Engineering Co., 133 No. 3rd St., Reading, Pa.
Falk Corp., Milwaukee, Wis.
Foote Bros. Gear & Mch. Co., 232-242 N. Curtis St., Chicago.
Jones Foundry & Mch. Co., W. A., 4409 W. Roosevelt Rd., Chicago.
Nicholson & Co., W. H., 112 Oregon St., Wilkes-Barre, Pa.
Nuttall Co., R. D., Pittsburgh.
Smith & Serrell, Newark, N. J.
Wood's Sons Co., T. B., Chambersburg, Pa.

COUPLINGS, PIPE

Dart Mfg. Co., E. M., Providence, R. I.

COUPLINGS, SHAFTS

Adamson Mch. Co., Akron, O.
Bond, Charles Co., Philadelphia.
Brown Co., A. F., 79 Barclay St., New York.
Brown Engineering Co., 133 N. Third St., Reading, Pa.
Foote Bros. Gear & Mch. Co., 232-242 N. Curtis St., Chicago.
Hilliard Clutch & Mch. Co., Elmira, N. Y.
Moore & White Co., 2707-2737 No. 15th St., Philadelphia.
Nicholson & Co., W. H., 112 Oregon St., Wilkes-Barre, Pa.
Royersford Fdry. & Mch. Co., 54 N. 5th St., Philadelphia.
Sellers & Co., Inc., Wm., Philadelphia.
Smith & Serrell, Newark, N. J.
Smith, Winfield H., Springville, N. Y.
Wood's Sons Co., T. B., Chambersburg, Pa.

CRANES

Hanna Engineering Works, 1763 Elston Ave., Chicago.
Harrington Company, Philadelphia, Pa.
Link-Belt Company, Chicago.
Niles-Bement-Pond Co., 111 Broadway, New York.
Wright Mfg. Co., Lisbon, O.

CRANES, ELECTRIC TRAVELING

Link-Belt Company, Chicago.
Niles-Bement-Pond Co., 111 Broadway, New York.
Roeper Crane & Hoist Works, Reading, Pa.

CRANES, HAND TRAVELING

Hanna Engineering Works, 1763 Elston Ave., Chicago.
Niles-Bement-Pond Co., 111 Broadway, New York.
Roeper Crane & Hoist Works, Reading, Pa.

CRANES, LOCOMOTIVE

Hanna Engineering Works, 1763 Elston Ave., Chicago.
Link-Belt Company, Chicago.

CRANES, PORTABLE

Canedy-Otto Mfg. Co., Chicago Heights, Ill.
Canton Fdry. & Mch. Co., Canton, O.

CRANK PIN TURNING MACHINES

American Tool Works Co., Cincinnati.
Lodge & Shipley Mch. Tool Co., Cincinnati.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia.
Underwood Corp., H. B., Philadelphia.

CRUCIBLES

Dixon Crucible Co., Joseph, Jersey City, N. J.

CUTTER COMPOUND

See Compound, Cutting, Grinding, etc.

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Barber-Colman Co., Rockford, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clark Cutter Co., Detroit, Mich.
Cleveland Twist Drill Co., Cleveland.
Columbus Die, Tool & Mch. Co., Columbus, O.
Consolidated Machine Tool Corp., Rochester, N. Y.
Gammons-Holman Co., Manchester, Conn.
Goddard & Goddard Co., Detroit.
Gould & Eberhardt, Newark, N. J.
Haynes Stellite Co., 30 E. 42nd St., New York.
Ingersoll Milling Mch. Co., Rockford, Ill.
Kearney & Trecker Corp., Milwaukee, Wis.
Lovejoy Tool Co., Inc., Springfield, Vermont.
Modern Tool Wks., Erie, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
National Tool Co., Cleveland.
National Twist Drill & Tool Co., Detroit, Mich.
Newark Gear Cutting Machine Co., Newark, N. J.
O. K. Tool Co., Inc., Shelton, Conn.
Pratt & Whitney Co, Hartford, Conn.
Reed-Prentice Co., Worcester, Mass.
Sommer & Adams Co., Cleveland.
Standard Tool Co., Cleveland.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Conn.

CUTTING-METALS OR ALLOYS

Haynes Stellite Co., 30 E. 42nd St., New York.

CUTTING-OFF MACHINES, ABRASIVE WHEEL

Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago.
Greenfield Tap & Die Corp., Greenfield, Mass.

CUTTING-OFF MACHINES, COLD SAW

See Sawing Machines, Circular.

CUTTING-OFF MACHINES, ROTARY

Brown & Sharpe Mfg. Co., Providence, R. I.
Curtis & Curtis Co., 324 Garden St., Bridgeport, Conn.
Etna Machine Co., Toledo, O.
Fawcus Machine Co., Toledo, O.
Hurlbut Rogers Mchy. Co., Nashua, N. H.

CUTTING-OFF TOOLS

Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago.
O. K. Tool Co., Inc., Shelton, Conn.
P. A. S. Mch. Tool Supply Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Conn.
Ready Tool Co., Bridgeport, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams, J. H., & Co., Buffalo, N. Y.

CYCLOMETERS

Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

CYLINDER BORING MACHINES

Baker Bros., Inc., Toledo, O.
Consolidated Machine Tool Corp., Rochester, N. Y.
Ingersoll Milling Mch. Co., Rockford, Ill.
Newton Machine Tool Works, Inc., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.

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Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia.
Underwood Corp., H. B., Philadelphia, Pa.

DEALERS, MACHINERY

Allen, H. F., Co., Inc., 30 Church St., New York.
Besly & Co., Charles H., 120-B No. Clinton St., Chicago.
Earle Gear & Machine Co., 4707 Stenton Ave., Philadelphia.
Eastern Machinery Co., Cincinnati.
Essley Machinery Co., E. L., 551-57 W. Washington Blvd., Chicago.
Hill, Clarke & Co., Inc., Boston.
Jones Machine Tool Co., Cincinnati.
Lucas & Son, Inc., J. L., Bridgeport, Conn.
Lynd-Farquhar Co., Boston, Mass.
Miles Machinery Co., Saginaw, Mich.
Niles-Bement-Pond Co., 111 Broadway, New York.
Osborne & Sexton Mchy. Co., Columbus, Ohio.
Osgood Tool Co., J. L., Buffalo, N. Y.
Prentiss & Co., Inc., Henry, 149 Broadway, New York.
Richey-Whaley Mchy. Co., Indianapolis, Ind.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.

DEMAGNETIZERS

Heald Machine Co., 16 New Bond St., Worcester, Mass.
Luma Electric Equipment Co., Toledo, Ohio.
Walker Company, Inc., O. S., Worcester, Mass.

DESIGNERS, MACHINE AND TOOL

Manufacturers Consulting Engineers, Syracuse, N. Y.
Ruthman Machinery Co., Cincinnati.

DIAMONDS, BORTZ AND CARBON

Acme Diamond Tool Co., 170 Broadway, New York.
Desmond-Stephan Mfg. Co., Urbana, O.
Francis & Co., Hartford, Conn.

DIAMOND TOOLS

Acme Diamond Tool Co., 170 Broadway, New York.
Desmond-Stephan Mfg. Co., Urbana, O.
Francis & Co., Hartford, Conn.

DIE BLOCKS

Dyson & Sons, Joseph, Cleveland, O.
Ludlum Steel Co., Watervliet, N. Y.

DIE CASTINGS

See Castings, Die or Die Molded.

DIE CUSHIONS, PNEUMATIC

Cochrane-Bly Co., Rochester, N. Y.
Marquette Tool & Mfg. Co., 321 West Ohio St., Chicago.

DIE MAKERS' SUPPLIES

Danly Machine Specialties, Inc., 4907 Lincoln Ave., Chicago.
U. S. Tool Co., Inc., Ampere, N. J.

DIE MILLING MACHINES

Cochrane-Bly Co., Rochester, N. Y.

DIE SETS, STANDARD

Danly Machine Specialties, 4907 Lincoln Ave., Chicago.
U. S. Tool Co., Inc., Ampere, N. J.

DIE SINKERS, AUTOMATIC

Keller Mechanical Engineering Corp., 74 Washington St., Brooklyn, N. Y.

DIE SINKING MACHINES

Cochrane-Bly Co., Rochester, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Reed-Prentice Co., Worcester, Mass.

DIE STOCKS

See Stocks, Die and Taps and Dies.

DIES, DROP FORGING

Keller Mechanical Engineering Corp., 74 Washington St., Brooklyn, N. Y.

DIES, DRAWING, PRESSURE ATTACHMENTS

King, R. D., 1620 Monadnock Block, Chicago.
Marquette Tool & Mfg. Co., 321 West Ohio St., Chicago.

DIES, LETTERING AND EMBOSSING

Noble & Westbrook Mfg. Co., Hartford, Conn.
Schwerdtle Stamp Co., Bridgeport, Conn.

DIES, SHEET METAL, ETC.

Active Machine & Tool Co., Cleveland.
Adriance Machine Works, Inc., 78 Richards St., Brooklyn, N. Y.
American Tool & Mfg. Co., Urbana, O.
Ams, Max, Machine Co., 101 Park Ave., New York.
Banner Die, Tool & Stamping Co., Columbus, O.
Bliss Co., E. W., Brooklyn, N. Y.
Columbus Die, Tool & Machine Co., Columbus, O.
Danly Machine Specialties, Inc., 4907 Lincoln Ave., Chicago.
Ferracute Machine Co., Bridgeton, N. J.
Geier Co., P. A., Cleveland.
Globe Mch. & Stamping Co., 1255 W. 76th St., Cleveland, O.
Keller Mechanical Engineering Corp., 74 Washington St., Brooklyn, N. Y.
King, R. D., 1620 Monadnock Block, Chicago.
Mehl Mch. Tool & Die Co., Roselle, N. J.
Pennsylvania Tool & Mfg. Co., York, Pa.
Production Engineering Corp., Canastota, N. Y.
Reliance Die & Stamping Co., 515 N. Lasalle St., Chicago.
Ruthman Machinery Co., Cincinnati.
Steel Products Engineering Co., Springfield, O.
Stoll Co., Inc., D. H., Buffalo, N. Y.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Taylor-Shantz Co., Rochester, N. Y.
Toledo Mch. & Tool Co., Toledo, O.
U. S. Tool Co., Inc., Ampere, N. J.
V & O Press Co., Hudson, N. Y.
Wade Tool Co., Waltham, Mass.
Waltham Machine Works, Waltham, Mass.

DIES, THREADING

Brubaker & Bros., W. L., 50 Church St., New York.
Butterfield & Co., Div. Union Twist Drill Co., Derby Line, Vt.
Card Mfg. Co., S. W., Div. Union Twist Drill Co., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Geometric Tool Co., New Haven, Ct.
Greenfield Tap & Die Corp., Greenfield, Mass.
Jones & Lamson Mch. Co., Springfield, Vermont.
Landis Mch. Co., Inc., Waynesboro, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
National Acme Co., Cleveland, O.
Oster Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Reed Mfg. Co., Erie, Pa.
Saunders' Sons, Inc., D., Yonkers, N. Y.
Standard Tool Co., Cleveland.
Threadwell Tool Co., Greenfield, Mass.

DIES, THREADING, OPENING

Butterfield & Co., Div. Union Twist Drill Co., Derby Line, Vt.
Consolidated Machine Tool Corp., Rochester, N. Y.
Eastern Machine Screw Corp., New Haven, Conn.
Errington Mechanical Laboratory, Broadway and John St., New York.
Geometric Tool Co., New Haven, Ct.
Greenfield Tap & Die Corp., Greenfield, Mass.
H & G Works, Eastern Mch. Screw Corp., New Haven, Conn.
Jones and Lamson Mch. Co., Springfield, Vermont.
Landis Machine Co., Inc., Waynesboro, Pa.
Modern Tool Co., Erie, Pa.
Murchey Mch. & Tool Co., 34 Porter St., Detroit.
National Acme Co., Cleveland, O.
Oster Mfg. Co., Cleveland, O.

DIES, THREAD ROLLING

Hanson-Whitney Mch. Co., Hartford, Conn.

DISCS, ABRASIVE

Badger Tool Co., Beloit, Wis.
Besly & Co., Charles H., 120-B No. Clinton St., Chicago.
Carborundum Co., Niagara Falls, N. Y.
Gardner Mch. Co., 414 Gardner St., Beloit, Wis.
Walls Sales Corp., 96 Warren St., New York.

DIVIDING HEADS

Knight Mchy. Co., W. B., St. Louis.
LeBlond, R. K., Machine Tool Co., Cincinnati.
See also Milling Machines, Horizontal, Universal.

DOWEL PINS

Danly Machine Specialties, Inc. 4907 Lincoln Ave., Chicago.

DRAFTING INSTRUMENTS

Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Keuffel & Esser Co., Hoboken, N. J.
Paragon Mch. Co., Rochester, N. Y.

DRAFTING MACHINES

Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Keuffel & Esser Co., Hoboken, N. J.
Universal Drafting Mch. Co., Cleveland, O.

DRAWING BOARDS AND TABLES

Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Keuffel & Esser Co., Hoboken, N. J.
Paragon Mch. Co., Rochester, N. Y.
Universal Drafting Mch. Co., Cleveland, O.

DRAWING MATERIALS

Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Keuffel & Esser Co., Hoboken, N. J.
Paragon Mch. Co., Rochester, N. Y.

DRESSERS, GRINDING WHEEL

Abrasive Co., Bridesburg, Philadelphia.
Acme Diamond Tool Co., 179 Broadway, New York.
Bridgeport Safety Emery Wheel Co., Inc., 1283 W. Broad St., Bridgeport, Conn.
Calder Co., George H., Lancaster, Pa.
Cleveland Stone Co., Cleveland.
Desmond-Stephan Mfg. Co., Urbana, O.
Francis & Co., Hartford, Conn.
Norton Co., Worcester, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Reed Mfg. Co., Erie, Pa.
Standard Tool Co., Cleveland, O.
Western Tool & Mfg. Co., Springfield, Ohio.

DRIFTS, DRILL

Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago.
Williams, J. H., & Co., Buffalo, N. Y.

DRILL HEADS, MULTIPLE

Baker Brothers, Inc., Toledo.
Barnes Drill Co., 814 Chestnut St., Rockford, Ill.
Errington Mechanical Laboratory, Broadway and John St., New York.
Hoefer Mfg. Co., Freeport, Ill.
National Automatic Tool Co., Richmond, Ind.
Rockford Drilling Machine Co., Rockford, Ill.
United States Drill Head Co., 1948 W. 6th St., Cincinnati.

DRILL RODS, CARBON AND HIGH SPEED

Anchor Drawn Steel Co., Latrobe, Pa.
Carpenter Steel Co., Reading, Pa.

DRILL SOCKETS

Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago.
Cleveland Twist Drill Co., Cleveland.
Greenfield Tap & Die Corp., Greenfield, Mass.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
National Twist Drill & Tool Co., Detroit, Mich.
Scully Jones & Co., 13th and Robey Sts., Chicago.
Standard Tool Co., Cleveland.
Union Twist Drill Co., Athol, Mass.

DRILL SPEEDERS

Graham Mfg. Co., Providence, R. I.
Hoefer Mfg. Co., Freeport, Ill.

DRILL STANDS

Cleveland Twist Drill Co., Cleveland.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Standard Tool Co., Cleveland.

DRILLING AND MILLING MACHINES, VERTICAL

Cochrane-Bly Co., Rochester, N. Y.
Knight Mchy. Co., W. B., St. Louis.
Moline Tool Co., Moline, Ill.

DRILLING MACHINES, AUTOMATIC

Baker Bros., Inc., Toledo, Ohio.
Barnes Co., W. F. & John, Rockford, Ill.
Barnes Drill Co., 814 Chestnut St., Rockford, Ill.
Cincinnati Automatic Mch. Co., Cincinnati.
Grant Mfg. & Mch. Co., N. W. Station, Bridgeport, Conn.
Hoefer Mfg. Co., Freeport, Ill.
Kingsbury Mfg. Co., Keene, N. H.

DRILLING MACHINES, BENCH

Ames Co., B. C., Waltham, Mass.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Buffalo Forge Co., Buffalo, N. Y.
Canedy-Otto Mfg. Co., Chicago Heights, Ill.
Cincinnati Electrical Tool Co., Cincinnati.
High Speed Hammer Co., Inc., Rochester, N. Y.
Kingsbury Mfg. Co., Keene, N. H.
Langelier Mfg. Co., Arlington, Cranston, R. I.
LeBlond, R. K., Machine Tool Co., Cincinnati.
Leland Gifford Co., Worcester, Mass.
National Automatic Tool Co., Richmond, Ind.
Rockford Drilling Machine Co., Rockford, Ill.
Sigourney Tool Co., 11 Sigourney St., Hartford, Conn.
Wisconsin Electric Co., Racine, Wis.

DRILLING MACHINES, BOILER

Cincinnati-Bickford Tool Co., Oakley, Cincinnati.
Foote-Burt Co., Cleveland.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Philadelphia.

DRILLING MACHINES, GANG

Baker Bros., Inc., Toledo, O.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Barnes Drill Co., 814 Chestnut St., Rockford, Ill.
Cincinnati-Bickford Tool Co., Oakley, Cincinnati.
Colburn Machine Tool Co., Rochester.
Consolidated Machine Tool Corp., Rochester, N. Y.
Foote-Burt Co., Cleveland.
Fosdick Mch. Tool Co., Cincinnati.
Hoefer Mfg. Co., Freeport, Ill.
Ingersoll Milling Machine Co., Rockford, Ill.
Kingsbury Mfg. Co., Keene, N. H.
Leland-Gifford Co., Worcester, Mass.
Langelier Mfg. Co., Arlington, Cranston, R. I.
Moline Tool Co., Moline, Ill.
Niles-Bement-Pond Co., 111 Broadway, New York.
Rockford Drilling Mch. Co., Rockford, Ill.
Rockford Mch. Tool Co., Rockford, Ill.
Sigourney Tool Co., 11 Sigourney St., Hartford, Conn.

DRILLING MACHINES, HEAVY DUTY

Avey Drilling Mch. Co., Cincinnati.
Baker Bros., Inc., Toledo, Ohio.
Barnes Drill Co., 814 Chestnut St., Rockford, Ill.
Colburn Machine Tool Co., Rochester.
Consolidated Machine Tool Corp., Rochester, N. Y.
Foote-Burt Co., Cleveland.
Hoefer Mfg. Co., Freeport, Ill.
Ingersoll Milling Mch. Co., Rockford, Ill.
Rockford Mch. Co., Rockford, Ill.

DRILLING MACHINES, HORIZONTAL, DUPLEX

Kingsbury Mfg. Co., Keene, N. H.
Langelier Mfg. Co., Arlington, Cranston, R. I.
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Kingsbury Mfg. Co., Keene, N. H.
Langelier Mfg. Co., Arlington, Cranston, R. I.
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National Automatic Tool Co., Richmond, Ind.
Pratt & Whitney Co., Hartford, Conn.
United States Drill Head Co., 1948 W. 6th St., Cincinnati.

DRILLING MACHINES, MULTIPLE SPINDLE, HORIZONTAL

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Harrington Company, Philadelphia, Pa.
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Kingsbury Mfg. Co., Keene, N. H.
Langelier Mfg. Co., Arlington, Cranston, R. I.
Moline Tool Co., Moline, Ill.
National Acme Co., Cleveland.
National Automatic Tool Co., Richmond, Ind.
United States Drill Head Co., 1948 W. 6th St., Cincinnati.

DRILLING MACHINES, MULTIPLE SPINDLE, TURRET

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Langelier Mfg. Co., Arlington, Cranston, R. I.

DRILLING MACHINES, MULTIPLE SPINDLE, VERTICAL

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Baker Bros., Inc., Toledo, O.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Barnes Drill Co., 814 Chestnut St., Rockford, Ill.
Cincinnati-Bickford Tool Co., Oakley, Cincinnati.
Colburn Machine Tool Co., Rochester.
Consolidated Machine Tool Corp., Rochester, N. Y.
Foote-Burt Co., Cleveland.
Greenlee Bros. & Co., Rockford, Ill.
Harrington Company, Philadelphia, Pa.
Ingersoll Milling Mch. Co., Rockford, Ill.
Kingsbury Mfg. Co., Keene, N. H.
Langelier Mfg. Co., Arlington, Cranston, R. I.
Leland Tool Co., Moline, Ill.
National Automatic Tool Co., Richmond, Ind.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pratt & Whitney Co., Hartford, Conn.
Rockford Drilling Mch. Co., Rockford, Ill.
Rockford Machine Tool Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia.
United States Drill Head Co., 1948 W. 6th St., Cincinnati.

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Cincinnati-Bickford Tool Co., Oakley, Cincinnati.
Cincinnati Electrical Tool Co., Cincinnati.
Dreses Machine Tool Co., Cincinnati.
Fosdick Machine Tool Co., Cincinnati.
Giddings & Lewis Mch. Tool Co., Fond du Lac, Wis.
Morris Machine Tool Co., Cincinnati.
Mueller Machine Tool Co., Cincinnati.
Niles-Bement-Pond Co., 111 Broadway, New York.
Reed-Prentice Co., Worcester, Mass.
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Consolidated Machine Tool Corp., Rochester, N. Y.
Foote-Burt Co., Cleveland.
General Electric Co., Schenectady, N. Y.
Harrington Company, Philadelphia, Pa.
Moline Tool Co., Moline, Ill.
Newton Machine Tool Works, Inc., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
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Foote-Burt Co., Cleveland.
Fosdick Mch. Tool Co., Cincinnati.
High Speed Hammer Co., Inc., Rochester, N. Y.
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Langelier Mfg. Co., Arlington, Cranston, R. I.
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Consolidated Machine Tool Corp., Rochester, N. Y.
Foote-Burt Co., Cleveland.
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Harrington Company, Philadelphia, Pa.
Hoefer Mfg. Co., Freeport, Ill.
Kingsbury Mfg. Co., Keene, N. H.
Langelier Mfg. Co., Arlington, Cranston, R. I.
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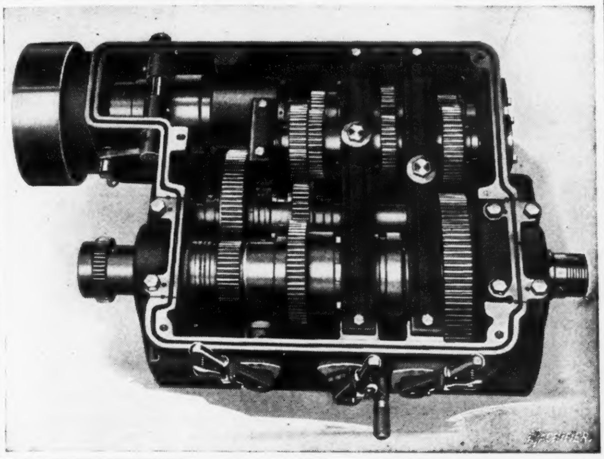

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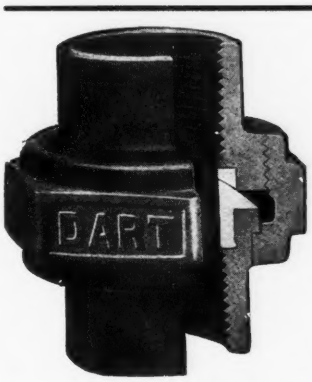

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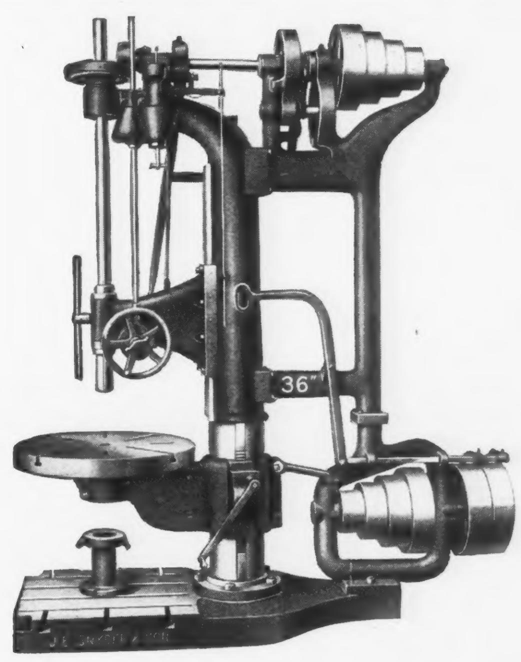

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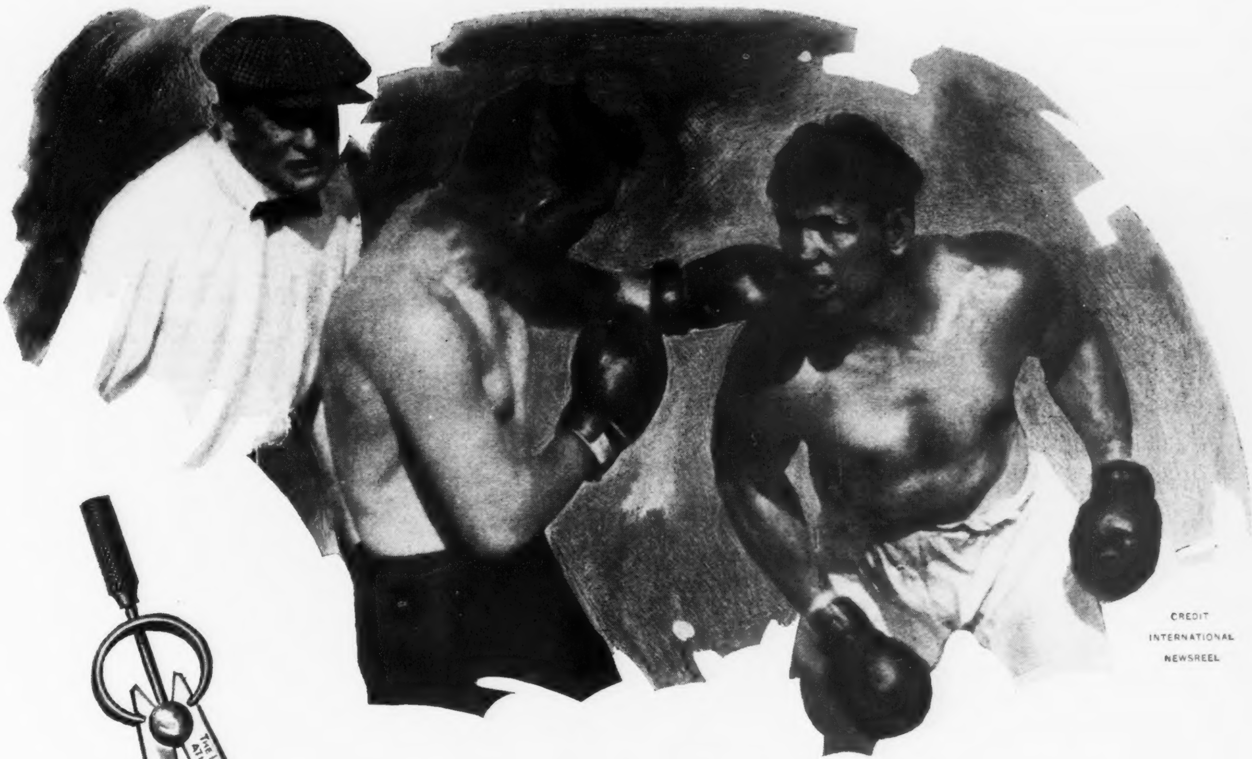
ALPHABETICAL INDEX OF ADVERTISERS, PAGES 283-284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Horsburgh & Scott Co., Cleveland.
Lees-Bradner Co., Cleveland.
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Earle Gear & Mch. Co., 4707 Stenton Ave., Philadelphia.
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Massachusetts Gear & Tool Co., Woburn, Mass.
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Newark Gear Cutting Machine Co., Newark, N. J.
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Pittsburgh Gear & Mch. Co., 2700 Smallman St., Pittsburgh.
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Simonds Mfg. Co., Pittsburgh.
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GREASE CUPS
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Builders Iron Fdry., Providence, R. I.
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Heim Grinder Co., Danbury, Conn.

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Greenfield Tap & Die Corp., Greenfield, Mass.
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Norton Co., Worcester, Mass.
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Modern Tool Co., Erie, Pa.
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Besly Co., Charles H., 120-B North Clinton St., Chicago.
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Porter-Cable Machine Co., Syracuse, N. Y.
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GRINDING MACHINE, MULTIPLE SPINDLE
Bryant Chucking Grinder Co., Springfield, Vt.

ALPHABETICAL INDEX OF ADVERTISERS, PAGES 283-284

GRINDING MACHINES, PATTERN-MAKERS, DISC
Gardner Machine Co., 414 E. Gardner St., Beloit, Wis.

GRINDING MACHINES, PIPE THREADING DIE
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See Gear Cutting Machines, Helical and Spur (Hob) and Gear Cutting Machines, Worm and Worm Wheel (Hob).

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Niles-Bement-Pond Co., 111 Broadway, New York.
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Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Watson-Stillman Co., 192 Fulton St., New York.
Williams, White & Co., Moline, Ill.

INDEX CENTERS
See also Milling Machines, Horizontal, Universal.
Abrasive Mch. Tool Co., East Providence, R. I.
Knight Mchy. Co., W. B., St. Louis.

INDICATORS, SPEED
Atkins & Co., Inc., E. C., Indianapolis, Ind.
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Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
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Watson-Stillman Co., 192 Fulton St., New York.

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Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago.

JIGS AND FIXTURES
American Tool & Mfg. Co., Urbana, Ohio.
Banner Die, Tool & Stamping Co., Columbus, O.
Brock Tool & Mfg. Co. Works, Arthur Jr., Philadelphia.
Columbus Die, Tool & Mch. Co., Columbus, O.
Garrison Machine Works, Dayton, O.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Geier Co., P. A., Cleveland.
Globe Mch. & Stamping Co., 1255 W. 76th St., Cleveland, O.
Ingersoll Milling Machine Co., Rockford, Ill.
Logansport Mch. Co., 529 Market St., Logansport, Ind.
Manufacturers' Consulting Engineers, Syracuse, N. Y.
Mehl Mch. Tool & Die Co., Roselle, N. J.
Moline Tool Co., Moline, Ill.
Pennsylvania Tool & Mfg. Co., York, Pa.
Pratt & Whitney Co., Hartford, Conn.
Production Engineering Corp., Canastota, N. Y.
Reliance Die & Stamping Co., 515 N. LaSalle St., Chicago.
Ruthman Machinery Co., Cincinnati.
Sommer & Adams Co., Cleveland.
Steel Products Engineering Co., Springfield, Ohio.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Taylor-Shantz Co., Rochester, N. Y.
Wade Tool Co., Waltham, Mass.
Wappat Gear Wks., Pittsburgh, Pa.

KETTLES, SODA
Brown & Sharpe Mfg. Co., Providence, R. I.

KEYSEATERS
Baker Bros., Inc., Toledo, O.
Consolidated Machine Tool Corp., Rochester, N. Y.
Davis Keyseater Co., Rochester, N. Y.
Lapointe Machine Tool Co., Hudson, Mass.
Mitts & Merrill, 843 Water St., Saginaw, Mich.
Morton Mfg. Co., Muskegon Heights, Mich.
Newton Machine Tool Works, Inc., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.

KEYSEATERS, PORTABLE
Burr & Son, John T., Brooklyn, N. Y.

KEYS, MACHINE
Moltrup Steel Products Co., Beaver Falls, Pa.
Morton Mfg. Co., Muskegon Heights, Mich.
Smith & Serrell, Newark, N. J.
Whitney Mfg. Co., Hartford, Conn.
Williams, J. H. & Co., Buffalo, N. Y.

KNIVES, MACHINE
Atkins & Co., Inc., E. C., Indianapolis, Ind.
Coes Wrench Co., Worcester, Mass.

KNURL HOLDERS
Graham Mfg. Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Conn.

KNURLING TOOLS
Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago.
Pratt & Whitney Co., Hartford, Conn.
Williams, J. H., & Co., Buffalo, N. Y.

LAMP GUARDS, ETC.
McCrosky Tool Corp., Meadville, Pa.

LAMPS, ELECTRIC
General Electric Co., Schenectady, N. Y.

ALPHABETICAL INDEX OF ADVERTISERS, PAGES 283-284

LAPPING MACHINES, POWER

Builders Iron Foundry, Providence, R. I.
Moline Tool Co., Moline, Ill.
Niles-Bement-Pond Co., 111 Broadway, New York.

LATHE ATTACHMENTS

American Tool Works, Cincinnati.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Barnes Drill Co., 814 Chestnut St., Rockford, Ill.
Bradford Mch. Tool Co., Cincinnati.
Champion Tool Works, 4955 Spring Grove Ave., Cincinnati.
Cisco Mch. Tool Co., Cincinnati.
Diamond Machine Co., Providence, R. I.
Flather Co., Nashua, N. H.
Greaves-Klusman Tool Co., Cincinnati.
Hendey Mch. Co., Torrington, Conn.
LeBlond Mch. Tool Co., R. K., Cincinnati.
Lodge & Shipley Machine Tool Co., Cincinnati.
Monarch Machine Tool Co., 209 Oak St., Sidney, O.
Mueller Mch. Tool Co., Cincinnati.
Rivett Lathe & Grinder Corp., Brighton, Boston.
Rockford Tool Co., Rockford, Ill.
Seneca Falls Machine Co., Seneca Falls, N. Y.
South Bend Lathe Works, Inc., South Bend, Ind.
Springfield Machine Tool Co., 631 Southern Ave., Springfield, O.
Stark Tool Co., Waltham, Mass.
Wade Tool Co., Waltham, Mass.

LATHE DOGS

Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago.
Ready Tool Co., Bridgeport, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams, J. H., & Co., Buffalo, N. Y.

LATHE DOGS, SAFETY

Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago.
Williams, J. H., & Co., Buffalo, N. Y.

LATHES, PLANER AND SHAPER TOOLS

Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Lovejoy Tool Co., Inc., Springfield, Vt.
McCrosky Tool Corp., Meadville, Pa.
O. K. Tool Co., Inc., Shelton, Conn.
Ready Tool Co., Bridgeport, Conn.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams, J. H., & Co., Buffalo, N. Y.

LATHES, AUTOMATIC

Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Jones & Lamson Machine Co., Springfield, Vt.
LeBlond, R. K., Mch. Tool Co., Cincinnati, O.
National Acme Co., Cleveland, O.
New Britain Machine Co., New Britain, Conn.
Potter & Johnston Machine Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Reed-Prentice Co., Worcester, Mass.
Rockford Machine Tool Co., Rockford, Ill.

LATHES, AUTOMATIC SCREW THREADING

Automatic Machine Co., Bridgeport, Conn.

LATHES, AXLE

Betts Machine Co., Rochester, N. Y.
Consolidated Machine Tool Corp., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Philadelphia.
Seneca Falls Machine Co., Seneca Falls, N. Y.

LATHES, BENCH

Ames Co., B. C., Waltham, Mass.
Diamond Mch. Co., Providence, R. I.
Elgin Tool Works, Inc., Elgin, Ill.
Hjorth Lathe & Tool Co., Boston.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Corp., Brighton, Boston.
Seneca Falls Machine Co., Seneca Falls, N. Y.
South Bend Lathe Works, Inc., South Bend, Ind.
Stark Tool Co., Waltham, Mass.
Van Norman Mch. Tool Co., Springfield, Mass.
Wade Tool Co., Waltham, Mass.

LATHES, BORING

Betts Machine Co., Rochester, N. Y.
Consolidated Machine Tool Corp., Rochester, N. Y.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
LeBlond, R. K., Machine Tool Co., Cincinnati.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Philadelphia.

LATHES, BRASS WORKERS

Acme Machine Tool Co., Cincinnati.
Bardons & Oliver, Cleveland.
Dreses Machine Co., Cincinnati.
Seneca Falls Machine Co., Seneca Falls, N. Y.
Springfield Machine Tool Co., 631 Southern Ave., Springfield, O.
Warner & Swasey Co., Cincinnati.

LATHES, CAR WHEEL

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Consolidated Machine Tool Corp., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Philadelphia.

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American Tool Works Co., Cincinnati.
Betts Machine Co., Rochester, N. Y.
Consolidated Machine Tool Corp., Rochester, N. Y.
LeBlond Machine Tool Co., R. K., Cincinnati.
Lodge & Shipley Machine Tool Co., Cincinnati.
Niles-Bement-Pond Co., 111 Broadway, New York.
Wickes Bros., Saginaw, Mich.

LATHES, DOUBLE-END

Greenlee Bros. & Co., Rockford, Ill.
Rockford Milling Machine Co., Rockford, Ill.

LATHES, ENGINE

American Tool Works Co., Cincinnati.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Barnes Drill Co., 814 Chestnut St., Rockford, Ill.
Betts Machine Co., Rochester, N. Y.
Boye & Emmes Machine Tool Co., Cincinnati.
Bradford Mch. Tool Co, Cincinnati.
Champion Tool Works, 4955 Spring Grove Ave., Cincinnati.
Cincinnati Lathe & Tool Co., Oakley, Cincinnati.
Cisco Machine Tool Co., Cincinnati.
Consolidatd Machine Tool Corp., Rochester, N. Y.
Earle Gear & Mch. Co., 4707 Stenton Ave., Philadelphia.
Flather Co., Nashua, N. H.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Greaves-Klusman Tool Co., Cincinnati.
Hendey Mch. Co., Torrington, Conn.
LeBlond Machine Tool Co., R. K., Cincinnati.
Lehmann Machine Co., St. Louis, Mo.
Lodge & Shipley Mch. Tool Co., Cincinnati.
Monarch Machine Tool Co., 209 Oak St. Sidney, O.
Morris Machine Tool Co., Cincinnati.
Mueller Mch. Tool Co., Cincinnati.
Niles-Bement-Pond Co., 111 Broadway, New York.
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Pratt & Whitney Co., Hartford, Conn.
Reed-Prentice Co., Worcester, Mass.
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Rockford Tool Co., Rockford, Ill.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Seneca Falls Machine Co., Seneca Falls, N. Y.
Sidney Machine Tool Co., Sidney, O.
South Bend Lathe Works, Inc., South Bend, Ind.
Springfield Machine Tool Co., 631 Southern Ave., Springfield, O.
Walcott Lathe Co., Jackson, Mich.
Wickes Bros., Saginaw, Mich.

LATHES, EXTENSION BED AND GAP

Barnes Drill Co., 814 Chestnut St., Rockford, Ill.
Harrington Company, Philadelphia, Pa.
LeBlond, R. K., Machine Tool Co., Cincinnati.
South Bend Lathe Works, Inc., South Bend, Ind.

LATHES, FOOT POWER

Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Seneca Falls Machine Co., Seneca Falls, N. Y.

LATHES, GUN BORING

Betts Machine Co., Rochester, N. Y.
Consolidated Machine Tool Corp., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
Springfield Mch. Tool Co., 631 Southern Ave., Springfield, O.

LATHES, PATTERNMAKERS'

Seneca Falls Machine Co., Seneca Falls, N. Y.
South Bend Lathe Works, Inc., South Bend, Ind.

LATHES, PULLEY

Avey Drilling Mch. Co., Cincinnati.

LATHES, SHAFT

Betts Machine Co., Rochester, N. Y.
Consolidated Machine Tool Corp., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Philadelphia.
Seneca Falls Machine Co., Seneca Falls, N. Y.

LATHES, SPEED

Diamond Machine Co., Providence, R. I.
Greenfield Tap & Die Corp., Greenfield, Mass.

LATHES, SPINNING

Adriance Machine Co., Inc., 78 Richards St., Brooklyn, N. Y.
Bliss Co., E. W., Brooklyn, N. Y.
Stoll Co., Inc., D. H., Buffalo, N. Y.
Toledo Mch. & Tool Co., Toledo, O.
See also Chucking Machines.

LATHES, TURRET

Acme Machine Tool Co., Cincinnati.
Bardons & Oliver, Cleveland.
Betts Machine Co., Rochester, N. Y.
Bullard Machine Tool Co., Bridgeport, Conn.
Consolidated Machine Tool Corp., Rochester, N. Y.
Dreses Machine Tool Co., Cincinnati.
Foster Machine Co., Elkhart, Ind.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Greaves-Klusman Tool Co., Cincinnati.
Greenlee Bros. & Co., Rockford, Ill.
International Mch. Tool Co., Indianapolis, Ind.
Jones & Lamson Machine Co., Springfield, Vt.
LeBlond, R. K., Machine Tool Co., Cincinnati.
Lodge & Shipley Mch. Tool Co., Cincinnati.
Morris Mch. Tool Co., Cincinnati.
New Britain Machine Co., New Britain, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Corp., Brighton, Mass.
Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio.
Stark Tool Co., Waltham, Mass.
Steinle Turret Machine Co., Madison, Wis.
Wade Tool Co., Waltham, Mass.
Warner & Swasey Co., Cleveland.

LATHES, WOODWORKERS'

Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Greenfield Tap & Die Corp., Greenfield, Mass.

LEATHER BELTING, ROUND

See Belting, Round Leather.

LEVELS

Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Keuffel & Esser Co., Hoboken, N. J.
Pratt & Whitney Co., Hartford, Conn.
Starrett Co., L. S., Athol, Mass.
Universal Boring Mch. Co., Hudson, Mass.

LOCKS FOR INDUSTRIAL PURPOSES

Yale & Towne Mfg. Co., Stamford, Conn.

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Dixon Crucible Co., Joseph, Jersey City, N. J.
Oakley Chemical Co., 26 Thames St., New York.
Royersford Fdry. & Mch. Co., 54 N. 5th St., Philadelphia.
Sun Oil Co., Philadelphia.

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Bowen Products Corp., Auburn, N. Y.
Greene, Tweed & Co., 109 Duane St., New York.
Royersford Fdry. & Mch. Co., 54 N. 5th St., Philadelphia.

MACHINISTS' SMALL TOOLS

See Calipers, Hammers, Wrenches, Drills, Taps, etc.

MALLETS, RAWHIDE

Chicago Rawhide Mfg. Co., 1309 Elston Ave., Chicago.

MANDRELS, EXPANDING AND SOLID

See Arbors and Mandrels, Expanding, and Solid.

MARKING MACHINES

Noble & Westbrook Mfg. Co., Hartford, Conn.
Preis & Co., Inc., H. P., Newark, N. J.
V & O Press Co., Hudson, N. Y.

MEASURING MACHINES, PRECISION

Federal Products Corp., Providence, R. I.
Ferner Co., R. Y., Washington, D. C.
Hanson-Whitney Mch. Co., Hartford, Conn.
Norma-Hoffmann Bearings Corp., Stamford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Scherr, George, 143 Liberty St., New York.

METALLOGRAPHIC EQUIPMENT

Bausch & Lomb Optical Co., Rochester, N. Y.

METALS, BEARING

See also Bearings Bronze, Babbitt, etc., and Bushings, Brass, Bronze, etc.

METALS, PERFORATED

Chicago Perforating Co., 2445 West 24th Place, Chicago.

MICROSCOPE, TOOLMAKERS'

Scherr, George, 143 Liberty St., New York.

MICROMETERS

Brown & Sharpe Mfg. Co., Providence, R. I.
Ferner Co., R. Y., Washington, D. C.
Pratt & Whitney Co., Hartford, Conn.
Scherr, George, 143 Liberty St., New York.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

MILLING AND DRILLING MACHINES, UPRIGHT

See Drilling and Milling Machines, Vertical.

MILLING AND SHAPING MACHINES

Cochrane-Bly Co., Rochester, N. Y.

MILLING ATTACHMENTS

Adams Co., Dubuque, Iowa.
Brown & sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mch. Co., Oakley, Cincinnati.
Elgin Tool Works, Inc., Elgin, Ill.
Hendey Mch. Co., Torrington, Conn.
Ingersoll Milling Machine Co., Rockford, Ill.
Kearney & Trecker Corp., Milwaukee, Wis.
LeBlond Mch. Tool Co., R. K., Cincinnati.
Oesterlein Machine Co., Cincinnati.
Porter-Cable Machine Co., Syracuse, N. Y.
Reed-Prentice Co., Worcester, Mass.
Rivett Lathe and Grinder Corp., Brighton, Boston.
Rockford Milling Machine Co., Rockford, Ill.
Taylor & Fenn Co., Hartford, Conn.
United States Machine Tool Co., Cincinnati.
Van Norman Mch. Tool Co., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

MILLING MACHINES, AUTOMATIC

Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Oakley, Cincinnati.
Ingersoll Milling Machine Co., Rockford, Ill.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Taylor & Fenn Co., Hartford, Conn.

MILLING MACHINES, BENCH

Ames Co., B. C., Waltham, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rockford Milling Machine Co., Rockford, Ill.
Stark tool Co., Waltham, Mass.
Van Norman Mch. Tool Co., Springfield, Mass.

MILLING MACHINES, CIRCULAR CONTINUOUS

Consolidated Machine Tool Corp., Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Ingersoll Milling Machine Co., Rockford, Ill.
Kearney & Trecker Corp., Milwaukee, Wis.
Newton Machine Tool Works, Inc., Rochester, N. Y.
Taylor & Fenn Co., Hartford, Conn.

MILLING MACHINES, DUPLEX

Ingersoll Milling Machine Co., Rockford, Ill.
Knight Mchy. Co., W. B., St. Louis.
Niles-Bement-Pond Co., 111 Broadway, New York.
Taylor & Fenn Co., Hartford, Conn.
Van Norman Mch. Tool Co., Springfield, Mass.

MILLING MACHINES, HAND

Brown & Sharpe Mfg. Co., Providence, R. I.
Kent-Owens Mch. Co., Toledo, O.
Pratt & Whitney Co., Hartford, Conn.
Rockford Milling Machine Co., Rockford, Ill.
United States Machine Tool Co., Cincinnati, O.
Van Norman Mch. Tool Co., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

MILLING MACHINES, HORIZONTAL, PLAIN

Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Oakley, Cincinnati.
Consolidated Machine Tool Corp., Rochester, N. Y.
Gallmeyer & Livingston Co., 344 Straight Ave., S. W., Grand Rapids, Mich.
Gooley & Edlund, Inc., Cortland, N. Y.
Hendey Mch. Co., Torrington, Conn.
Ingersoll Milling Machine Co., Rockford, Ill.
Kearney & Trecker Corp., Milwaukee, Wis.
LeBlond Mch. Tool Co., R. K., Cincinnati.
McCrosky Tool Corp., Meadville, Pa.
Newton Machine Tool Works, Inc., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
Oesterlein Machine Co., Cincinnati.
Rockford Milling Machine Co., Rockford, Ill.
Ryerson & Son, Joseph T., 2558 W 16th St., Chicago.

MILLING MACHINES, HORIZONTAL, UNIVERSAL

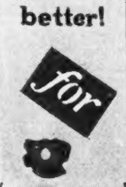
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Oakley, Cincinnati.
Gallmeyer & Livingston Co., 344 Straight Ave., S. W., Grand Rapids, Mich.
Hendey Mch. Co., Torrington, Conn.

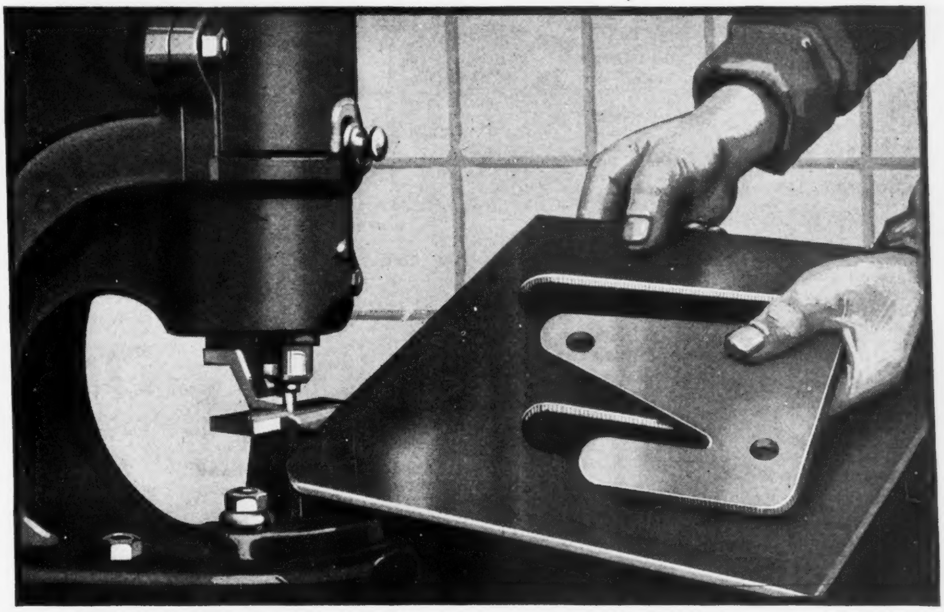
ALPHABETICAL INDEX OF ADVERTISERS, PAGES 283-284

Do you make pieces like these?

of any sheet metal, celluloid, Bakelite, or any composition?

The Nibbler will do them faster and better!





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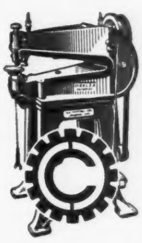
One user says: "It is the outstanding development in machine tools of recent years and merits the Franklin Medal".

A Nibbling Machine cuts or "nibbles" a narrow path through sheet-metal at a rate hitherto thought impossible—20 to 30 inches a minute. With it, internal and external designs of any shape can be cut *forty* times faster than drilling! Think how quickly you could "nibble" out templates, stripper plates, cams, gauges, gaskets, discs, flanges, patterns, etc.



The "Nibbler" cuts close to the line without burr or distortion of the metal. Finishing is reduced to a minimum. Cuts any sheet-metal, celluloid or composition, up to 3/8-inch in thickness.

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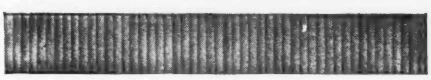
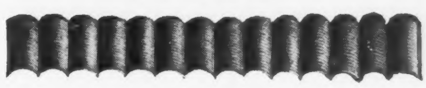


Drilled



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The only Nibbling Machine

"forty times faster than drilling"

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Write—Let us send you valuable data showing how much time and money the "Nibbler" is saving others—and will save you. Use the coupon—fill it out *now*—no obligation.

Mail this Coupon for "Nibbling" Data

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Gentlemen: We enclose a print of a typical sheet-metal drilling job on which we would like to have "Nibbling" time. Also send us folder showing different machines and work they will do.

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Address ______________________

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Rockford Milling Machine Co., Rockford, Ill.
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Van Norman Mch. Tool Co., Springfield, Mass.

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Niles-Bement-Pond Co., 111 Broadway, New York.

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Newton Machine Tool Works, Inc., Rochester, N. Y.
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Kearney & Trecker Corp., Milwaukee, Wis.
Knight Mchy. Co., W. B., St. Louis.
Newton Machine Tool Works, Inc., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
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Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
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Van Norman Mch. Tool Co., Springfield, Mass.

MILLING TOOLS, HOLLOW ADJUSTABLE

Geometric Tool Co., New Haven, Ct.

MODEL AND EXPERIMENTAL WORK

See Special Machinery and Tools.

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Hanna Engineering Works, 1763 Elston Ave., Chicago.

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Master Electric Co., 448 First St., Dayton, O.
Ohio Electric & Controller Co., Cleveland, Ohio.
Reliance Electric & Eng. Co., 1056 Ivanhoe Road, Cleveland.
Westinghouse Elec. Mfg. Co., East Pittsburgh, Pa.

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Schwerdtle Stamp Co., Bridgeport, Conn.

NAME PLATES, ETCHED

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Schwerdtle Stamp Co., Bridgeport, Conn.

NAME PLATES, STAMPED

Noble & Westbrook Mfg. Co., Hartford, Conn.
Schwerdtle Stamp Co., Bridgeport, Conn.

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Driver-Harris Co., Harrison, N. J.

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Merrell Mfg. Co., 15 Curtis St., Toledo, O.
Murchey Mch. & Tool Co., 34 Porter St., Detroit.
Saunders' Sons, Inc., D., Yonkers, N. Y.

NUTS, CASTELLATED

National Acme Co., Cleveland, O.

NUT TAPPERS

See Bolt and Nut Machinery.

ODOMETERS

Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

OIL CUPS

Besly & Co., Charles H., 120-B No. Clinton St., Chicago.
Bowen Products Corp., Auburn, N. Y.
Gits Bros. Mfg. Co., 1911 S. Kilbourne Ave., Chicago.
Tucker, W. M. & C. F., Hartford, Conn.

OILERS

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OILERS, LOOSE PULLEY

Brown Engineering Co., 133 No. 3rd St., Reading, Pa.

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OIL GROOVING TOOLS

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OIL HOLE COVERS

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Tucker, W. M. & C. F., Hartford, Conn.

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Sun Oil Co., Philadelphia.

OILS, QUENCHING AND TEMPERING

Sun Oil Company, Philadelphia.

OILS, SOLUBLE

See Compound, Cutting, Grinding, Etc.

OVENS, BAKING

American Gas Furnace Co., Elizabeth, N. J.
General Electric Co., Schenectady, N. Y.

OVEN, TEMPERING

General Electric Co., Schenectady, N. Y.

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Chicago Rawhide Mfg. Co., 1309 Elston Ave., Chicago.

PARALLELS

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Taft-Peirce Mfg. Co., Woonsocket, R. I.
Walker Company, Inc., O. S., Worcester, Mass.

PATENTS

Parker, C. L., Washington, D. C.

PATTERN SHOP MACHINERY

Crescent Machine Co., 56 Main St., Leetonia, O.
Porter-Cable Machine Co., Syracuse, N. Y.

PATTERNS, METAL

Mummert-Dixon Co., Hanover, Pa.
Sweet & Doyle Foundry & Mch. Co., Troy, Green Island, N. Y.
V & O Press Co., Hudson, N. Y.

PATTERNS, WOOD

Sweet & Doyle Fdry. & Mch. Co., Troy, Green Island, N. Y.
V & O Press Co., Hudson, N. Y.

PENCILS, DRAWING

American Lead Pencil Co., 237 Fifth Ave., New York.
Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Dixon Crucible Co., Joseph, Jersey City, N. J.

PHOSPHOR BRONZE

See Bronze.

PINION CUTTERS, AUTOMATIC

Wade Tool Co., Waltham, Mass.

PINIONS, FORGED

See Gears, Forged.

PIPE, STEEL

National Tube Co., Pittsburgh.

PIPE BENDING TOOLS

Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia.
Underwood Corp., H. B., Philadelphia.

PIPE CUTTING AND THREADING MACHINES

Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Machine Works, Edwardsville, Ill.
Curtis & Curtis Co., 324 Garden St., Bridgeport, Conn.
Foote-Burt Co., Cleveland.
Greenfield Tap & Die Corp., Greenfield, Mass.
Landis Machine Co., Inc., Waynesboro, Pa.
Merrell Mfg. Co., 15 Curtis St., Toledo, O.
Murchey Mch. & Tool Co., 34 Porter St., Detroit, Mich.
Niles-Bement-Pond Co., 111 Broadway, New York.
Oster Mfg. Co., Cleveland.
Saunders' Sons, Inc., D., Yonkers, N. Y.
Williams Tool Corp., Erie, Pa.

PLANER ATTACHMENTS

Cincinnati Planer Co., Cincinnati.
Gray Co., G. A., Cincinnati.
Hanson-Whitney Machine Co., Hartford, Conn.

PLANERS

American Tool Works Co., Cincinnati.
Bethlehem Steel Co., Bethlehem, Pa.
Betts Machine Co., Rochester, N. Y.
Cincinnati Planer Co., Cincinnati.
Cleveland Planer Co., Cleveland, O.
Consolidated Machine Tool Corp., Rochester, N. Y.
Gray Co., G. A., Cincinnati.
Liberty Mch. Tool Co., Hamilton, O.
Morton Mfg. Co., Muskegon Heights, Mich.
Niles-Bement-Pond Co., 111 Broadway, New York.
Reed-Prentice Co., Worcester, Mass.
Rockford Mch. Tool Co., Rockford, Ill.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Sellers & Co., Inc., Wm., Philadelphia.
Woodward & Powell Planer Co., Worcester, Mass.

PLANERS, CRANK

Cincinnati Shaper Co., Cincinnati.
Consolidated Machine Tool Corp., Rochester, N. Y.
Newton Mch. Tool Works, Inc., Rochester, N. Y.
Woodward & Powell Planer Co., Worcester, Mass.

PLANERS, OPEN-SIDE

Automatic Mch. Co., Bridgeport, Conn.
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Cincinnati Planer Co., Cincinnati.
Cleveland Planer Co., Cleveland, O.
Liberty Mch. Tool Co., Hamilton, O.

PLANERS, PORTABLE

Morton Mfg. Co., Muskegon Heights, Mich.
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PLANERS, ROTARY

Cleveland Punch & Shear Works Co., Cleveland.
Consolidated Machine Tool Corp., Rochester, N. Y.
Newton Machine Tool Works, Inc., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pedrick Tool & Machine Co., 3639 No. Lawrence St., Philadelphia.
Underwood Corp., H. B., Philadelphia.

PLATE ROLLS

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Cleveland Punch & Shear Works Co., Cleveland.
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Wickes Bros., Saginaw, Mich.

PLATES, STEEL

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Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.

PLATES, SURFACE

Brown & Sharpe Mfg. Co., Providence, R. I.
Taft-Peirce Mfg. Co., Woonsocket, R. I.

PLUG, TOOLMAKER EXPANDING

Taft-Peirce Mfg. Co., Woonsocket, R. I.

PNEUMATIC DIE CUSHIONS FOR POWER PRESSES

Marquette Tool & Mfg. Co., 321 W. Ohio St., Chicago.

PNEUMATIC TOOLS

Chicago Pneumatic Tool Co., 6 E. 44th St., New York.
Ingersoll-Rand Co., 11 Broadway, New York.
Logansport Mch. Co., 529 Market St., Logansport, Ind.

POLISHING MACHINES

Abbott Ball Co., Elmwood, Hartford, Conn.
Badger Tool Co., Beloit, Wis.
Besly & Co., Charles H., 120-B North Clinton St., Chicago.
Bridgeport Safety Emery Wheel Co., Inc., 1283 W. Broad St., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati.
Cleveland Stone Co., Cleveland.
Diamond Mch. Co., Providence, R. I.
Gardner Machine Co., 414 E. Gardner St., Beloit, Wis.
Geier Co., P. A., Cleveland.
Marschke Mfg. Co., Indianapolis, Ind.
New Britain Machine Co., New Britain, Conn.
Production Machine Co., Greenfield, Mass.
Royersford Fdry. & Mch. Co., 54 N. 5th St., Philadelphia.
Stow Mfg. Co., Binghamton, N. Y.

POTS, ANNEALING

Farrell-Cheek Steel Foundry Co., Sandusky, O.

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American Broach & Machine Co., Ann Arbor, Mich.
Atlas Press Co., Kalamazoo, Mich.
Canedy-Otto Mfg. Co., Chicago Heights, Ill.
Geier Co., P. A., Cleveland.
Logansport Mch. Co., 529 Market St., Logansport, Ind.
Lucas Machine Tool Co., Cleveland.
Nicholson & Co., W. H., 112 Oregon St., Wilkes-Barre, Pa.

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Adriance Mch. Works, Inc., 78 Richards St., Brooklyn, N. Y.
American Broach & Machine Co., Ann Arbor, Mich.
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Atlas Press Co., Kalamazoo, Mich.
Bliss Co., E. W., Brooklyn, N. Y.
Ferracute Machine Co., Bridgeton, N. J.
Lucas Machine Tool Co., Cleveland, O.
Oilgear Co., Milwaukee, Wis.
Stoll Co., Inc., D. H., Buffalo, N. Y.
Threadwell Tool Co., Greenfield, Mass.
Toledo Machine & Tool Co., Toledo, O.
V & O Press Co., Hudson, N. Y.
Watson-Stillman Co., 192 Fulton St., New York.

PRESSES, DROP

See Hammers, Drop.

PRESSES, FOOT

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Baird Mch. Co., Bridgeport, Conn.
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Niagara Mch. & Tool Works, Buffalo, N. Y.
Shuster Co., F. B., New Haven, Conn.
Stoll Co., Inc., D. H., Buffalo, N. Y.
Taylor & Fenn Co., Hartford, Conn.
Toledo Machine & Tool Co., Toledo, O.
V & O Press Co., Hudson, N. Y.

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Ferracute Machine Co., Bridgeton, N. J.
Stoll Co., Inc., D. H., Buffalo, N. Y.
Toledo Mch. & Tool Co., Toledo, O.
V & O Press Co., Hudson, N. Y.

PRESSES, HYDRAULIC

Bethlehem Steel Co., Bethlehem, Pa.
Chambersburg Engineering Co., Chambersburg, Pa.
Elmes Engineering Works, Charles F., 222 North Morgan St., Chicago.
Farrel Fdry. & Mch. Co., Buffalo, N. Y.
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio.
Niles-Bement-Pond Co., 111 Broadway, New York.
Oilgear Co., Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia.
Southwark Foundry & Machine Co., Philadelphia.
Watson-Stillman Co., 192 Fulton St., New York.
West Tire Setter Co., Rochester, N. Y.

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Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Elmes Engineering Works, Charles F., 222 North Morgan St., Chicago.
Lucas Machine Tool Co., Cleveland.
Southwark Foundry & Machine Co., Philadelphia.

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Littell Machine Co., F. J., 4125 Ravenswood Ave., Chicago.
S & S Machine Works, 4539-41 W. Lake St., Chicago.
Toledo Mch. & Tool Co., Toledo, O.
V & O Press Co., Hudson, N. Y.

PRESSES, SCREW

Adriance Mch. Works, Inc., 78 Richards St., Brooklyn, N. Y.
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Bliss Co., E. W., Brooklyn, N. Y.
Ferracute Machine Co., Bridgeton, N. J.
Globe Mch. & Stamping Co., 1255 W. 76th St., Cleveland, O.
Niagara Machine & Tool Works, Buffalo, N. Y.
Shuster Co., F. B., New Haven, Conn.
Toledo Mch. & Tool Co., Toledo, O.

PRESSES, SHEET METAL WORKING

Adriance Mch. Works, Inc., 78 Richards St., Brooklyn, N. Y.
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Baird Mch. Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Cleveland Punch & Shear Works Co., Cleveland.
Ferracute Machine Co., Bridgeton, N. J.
King, R. D., 1620 Monadnock Block, Chicago.
Loshbough-Jordan Tool & Mch. Co., Elkhart, Ind.
Loy & Nawrath, Div. Birmingham Iron Foundry, Derby, Conn.
Niagara Machine Tool Works, Buffalo, N. Y.

ALPHABETICAL INDEX OF ADVERTISERS, PAGES 283-284

ALPHABETICAL INDEX OF ADVERTISERS, PAGES 283-284

SAWING MACHINES, CIRCULAR
Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago.
Burr & Co., John T., Brooklyn, N. Y.
Cochrane-Bly Co., Rochester, N. Y.
Consolidated Machine Tool Corp., Rochester, N. Y.
Earle Gear & Machine Co., 4707 Stenton Ave., Philadelphia.
Espen-Lucas Machine Works, Philadelphia.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hanna Engineering Works, 1763 Elston Ave., Chicago.
Newton Machine Tool Works, Inc., Rochester, N. Y.

SAWING MACHINES, FRICTION
Hunter Saw & Mch. Co., Pittsburgh.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.

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Ajax Mfg. Co., Cleveland, O.
Armstrong-Blum Mfg. Co., 343 No. Francisco Ave., Chicago.
Atkins & Co., Inc., E. C., Indianapolis, Ind.
Racine Tool & Machine Co., 250 15th St. Racine, Wis.

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Armstrong-Blum Mfg. Co., 343 No. Francisco Ave., Chicago.
Atkins & Co., Inc., E. C., Indianapolis, Ind.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Hanna Engineering Works, 1763 Elston Ave., Chicago.
Millers Falls Co., Millers Falls, Mass.
Peerless Machine Co., Racine, Wis.
Racine Tool & Machine Co., 250 15th St., Racine, Wis.
Victor Saw Works, Inc., Middletown, N. Y.
Western Tool & Mfg. Co., Springfield, Ohio.

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Crescent Machine Co., 56 Main St., Leetonia, O.

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Atkins & Co., Inc., E. C., Indianapolis, Ind.

SAWS, SCREW SLOTTING
Atkins & Co., Inc., E. C., Indianapolis, Ind.
Barber-Colman Co., Rockford, Ill.
Greenfield Tap & Die Corp., Greenfield, Mass.
Starrett Co., L. S., Athol, Mass.

SCRAPING TOOLS, METAL POWER DRIVEN
Anderson Bros. Mfg. Co., Rockford, Ill.

SCREENS, PERFORATED
Chicago Perforating Co., 2445 West 24th Place, Chicago.

SCREW CUTTING TOOLS
See Taps and Dies.

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Errington Mechanical Laboratory, Broadway and John St., New York.
Strand & Co., M. A., 5001 N. Lincoln St., Chicago.

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New Britain Machine Co., New Britain, Conn.
Townsend, H. P., Mfg. Co., Hartford, Conn.

SCREW MACHINES, HAND
See also Lathes, Turret.
Acme Machine Tool Co., Cincinnati.
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Brown & Sharpe Mfg. Co., Providence, R. I.
Dreses Machine Tool Co., Cincinnati.
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Greenfield Tap & Die Corp., Greenfield, Mass.
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Wade Tool Co., Waltham, Mass.
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Cone Automatic Machine Co., Inc., Windsor, Vt.
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New Britain Machine Co., New Britain, Conn.

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New Britain Machine Co., New Britain, Conn.
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Albaugh-Dover Mfg. Co., 2147 Marshall Blvd., Chicago.
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New Britain Machine Co., New Britain, Conn.
Poorman, J. E., Philadelphia.
Reliance Die & Stamping Co., 515 No. LaSalle St., Chicago.
Standard Pressed Steel Co., Jenkintown, Pa.
Wappat Gear Wks., Pittsburgh, Pa.
Wicaco Screw & Mch. Works, Inc., Philadelphia.

SCREW PLATES
Besly & Co., Charles H., 120-B No. Clinton St., Chicago.
Brubaker & Bros. Co., W. L., 50 Church St., New York.
Butterfield & Co., Div. Union Twist Drill Co., Derby Line, Vt.
Card Mfg. Co., S. W., Div. of Union Twist Drill Co., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hjorth Lathe & Tool Co., Boston.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Mass.
Threadwell Tool Co., Greenfield, Mass.

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Allen Mfg. Co., Hartford, Conn.
National Acme Co., Cleveland, O.
Poorman, J. E., Philadelphia.
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SCREWS, MACHINE
Allen Mfg. Co., Hartford, Conn.
National Acme Co., Cleveland, O.
Poorman, J. E., Philadelphia.

SCREWS, SAFETY SET
See Heading—Set Screws, Safety

SCREW, SPECIAL LEAD, FEED, ETC.
Alling-Lander Co., Inc., Sodus, N. Y.
Automatic Mch. Co., Bridgeport, Conn.
Ferner Co., R. Y., Washington, D. C.
Hindley Gear Co., Philadelphia.

SEAMLESS STEEL TUBING
See Tubing. Seamless Steel.

SECOND-HAND MACHINERY, ETC.
Allen, H. F., Co., Inc., 30 Church St., New York.
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General Electric Co., Used Mchy. Dept., Erie, Pa.
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Prentiss & Co., Inc., Henry, 149 Broadway, New York
Reliance Machinery Sales Co., Pittsburgh, Pa.
Richey-Whaley Mchy. Co., Indianapolis, Ind.
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Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

SEPARATORS, CENTRIFUGAL
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Tolhurst Mch. Works, Troy, N. Y.
Magnetic Mfg. Co., Milwaukee, Wis.

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Allen Mfg. Co., Hartford, Conn.
Bristol Co., Waterbury, Conn.
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SHAFTING STEEL
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Moltrup Steel Products Co., Beaver Falls, Pa.
Royersford Fdry. & Mch. Co., 54 N. 5th St., Philadelphia.
Standard Pressed Steel Co., Jenkintown, Pa.
Union Drawn Steel Co., Beaver Falls, Pa.

SHAFTING, STEEL TUBING FOR
National Tube Co., Pittsburgh.

SHAFTS, FLEXIBLE
Chicago Flexible Shaft Co., 1154 S. Central Ave., Chicago.
Errington Mechanical Laboratory, Broadway and John St., New York.
Haskins Company, R. G., 520 W. Monroe St., Chicago, Ill.
Oliver Instrument Co., 1410 East Maumee St., Adrian, Mich.
Roller Bearing Co. of America, Newark, N. J.
Stow Mfg. Co., Binghamton, N. Y.
Strand & Co., N. A., 5001 N. Lincoln St., Chicago.

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Potter & Johnston Machine Co., Pawtucket, R. I.
Rhodes Mfg. Co., Hartford, Conn.
Rockford Machine Tool Co., Rockford, Ill.
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Springfield Mch. Tool Co., 631 Southern Ave., Springfield, O.
Steel Products Engineering Co., Springfield, O.
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SHAPERS, TRAVELING HEAD
Cincinnati Shaper Co., Cincinnati.
Niles-Bement-Pond Co., 111 Broadway, New York

SHAPERS, VERTICAL
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Toledo Mch. & Tool Co., Toledo, O.

SHEARS, SQUARING
Cleveland Punch & Shear Works Co., Cleveland.
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Niagara Mch. & Tool Works, Buffalo, N. Y.
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Toledo Mch. & Tool Co., Toledo, O.

SHEAVE WHEELS
Jones Foundry & Mch. Co., W. A., 4409 W. Roosevelt Rd., Chicago.
Wood's Sons Co., T. B., Chambersburg, Pa.

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Adriance Machine Works, Inc., 75 Richards St., Brooklyn, N. Y.
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Niagara Machine & Tool Works, Buffalo, N. Y.
Toledo Mch. & Tool Co., Toledo, O.
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Union Twist Drill Co., Athol, Mass.

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Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
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Newton Machine Tool Works, Inc., Rochester, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
Rhodes Mfg. Co., Hartford, Conn.
Sellers & Co., Inc., Wm., Philadelphia.

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Cleveland Twist Drill Co., Cleveland.
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Standard Tool Co., Cleveland.
Union Twist Drill Co., Athol, Mass.
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Active Machine & Tool Co., Cleveland, Ohio.
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Bilgram Machine Works, 1231 Spring Garden St., Philadelphia.
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Brock Tool & Mfg. Works, Arthur, Jr., Philadelphia.
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Consolidated Machine Tool Corp., Rochester, N. Y.
Earle Gear & Machine Co., 4707 Stenton Ave., Philadelphia.
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Fawcus Machine Co., Pittsburgh.
Ferner Co., R. Y., Washington, D. C.
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King, R. D., 1620 Monadnock Block, Chicago.
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Meisel Press Mfg. Co., 948 Dorchester Ave., Boston 25, Mass.
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ALPHABETICAL INDEX OF ADVERTISERS, PAGES 283-284

National Acme Co., Cleveland, O.
National Automatic Tool Co., Richmond, Ind.
National Machine Co., Tiffin, O.
National Tool Co., Cleveland.
National Twist Drill & Tool Co., Detroit, Mich.
Newton Machine Tool Works, Inc., Rochester, N. Y.
Niagara Machine & Tool Works, Buffalo, N. Y.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pratt & Whitney Co., Hartford, Conn.
Production Engineering Corp., Canastota, N. Y.
Reed-Prentice Co., Worcester, Mass.
Reliance Die & Stamping Co., 515 N. LaSalle St., Chicago.
Rockford Machine Tool Co., Rockford, Ill.
Ruthman Machinery Co., Cincinnati.
S & S Machine Work, 4539-41 W. Lake St., Chicago.
Shuster Co., F. B., New Haven, Conn.
Simonds Mfg. Co., Pittsburgh, Pa.
Steel Products Engineering Co., Springfield, O.
Sweet & Doyle Fdry. & Mch. Co., Troy, Green Island, N. Y.
Taylor-Shantz Co., Rochester, N. Y.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Toledo Mch. & Tool Co., Toledo, O.
V & O Press Co., Hudson, N. Y.
Wade Tool Co., Waltham, Mass.
Waltham Mch. Works, Waltham, Mass.
Wappat Gear Wks., Pittsburgh, Pa.
Wicaco Screw & Mch. Wks., Inc., Philadelphia.

SPEED REDUCERS
Adamson Mch. Co., Akron, O.
Alling-Lander Co., Inc., Sodus, N. Y.
Brown Co., A. & F., 79 Barclay St., New York.
Falk Corp., Milwaukee, Wis.
Farrell Fdry. & Mch. Co., Buffalo, N. Y.
Foote Bros. Gear & Mch. Co., 232-242 N. Curtis St., Chicago.
Ganschow Co., Wm., 16 No. Morgan St., Chicago.
James Mfg. Co., D. O., 112 West Monroe St., Chicago.
Jones Foundry & Machine Co., W. A., 4409 W. Roosevelt Rd., Chicago.
Moore & White Co., 2707-2737 No. 15th St., Philadelphia.
Niles-Bement-Pond Co., 111 Broadway, New York.
Philadelphia Gear Works, Philadelphia.
Smith, Winfield H., Springville, N. Y.

SPINDLES, HOLLOW BORED
American Hollow Boring Co., Erie, Pa.

SPINNING LATHES
See Lathes, Spinning.

SPOT FACERS
Gairing Tool Co., Inc., Detroit.

SPRING COILING AND FORMING MACHINERY
Baird Machine Co., Bridgeport, Conn.
Hjorth Lathe & Tool Co., Boston.

SPRINGS
Chatillon & Sons, John, 99 Cliff St., New York.

SPROCKET CHAINS
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Wks. Sales Co., Norfolk, Downs, Quincy, Mass.
Cullman Wheel Co., 1339 Altgeld St., Chicago.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Link-Belt Company, Chicago.
Morse Chain Co., Ithaca, N. Y.
Philadelphia Gear Works, Philadelphia.
Ramsay Chain Co., Inc., Albany, N. Y.
Whitney Mfg. Co., Hartford, Conn.

SPROCKETS
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Wks. Sales Co., Norfolk, Downs, Quincy, Mass.
Cullman Wheel Co., 1339 Altgeld St., Chicago.
Foote Bros. Gear & Mch. Co., 232-242 N. Curtis St., Chicago.
Jones Foundry & Mch. Co., W. A., 4409 W. Roosevelt Rd., Chicago.
Link-Belt Company, Chicago.
Mass. Gear & Tool Co., Woburn, Mass.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston 25, Mass.
Morse Chain Co., Ithaca, N. Y.
Philadelphia Gear Works, Philadelphia.
Stranahan Gear Co., Philadelphia.
Whitney Mfg. Co., Hartford, Conn.

SPRUE CUTTERS
Hanna Engineering Works, 1763 Elston Ave., Chicago.

STAMPINGS, SHEET METAL
Alemite Die-Casting & Mfg. Co., 2640-54 Belmont Ave., Chicago.
American Tool & Mfg. Co., Urbana, Ohio.
Banner Die, Tool & Stamping Co., Columbus, O.
Breese Bros. Co., Cincinnati, O.
Bridgeport Brass Co., Bridgeport, Conn.
Globe Mch. & Stamping Co., 1255 W. 76th St., Cleveland, O.
King, R. D., 1620 Monadnock Block, Chicago.
New Britain Machine Co., New Britain, Conn.

STAMPS, STEEL AND MARKING DIES
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Noble & Westbrook Mfg. Co., Hartford, Conn.
Schwerdtle Stamp Co., Bridgeport, Ct.

STEEL
Carpenter Steel Co., Reading, Pa.
Central Steel Co., Massillon, O.
Colonial Steel Co., Pittsburgh, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Hawkridge Bros. Co., Boston, Mass.
Ludlum Steel Co., Watervliet, N. Y.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Simonds Saw & Steel Co., Fitchburg, Mass.
Vanadium-Alloys Steel Co., Latrobe, Pa.
Vulcan-Crucible Steel Co., Aliquippa, Pa.

STEEL, COLD DRAWN
Anchor Drawn Steel Co., Latrobe, Pa.
Moltrup Steel Products Co., Beaver Falls, Pa.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Union Drawn Steel Co., Beaver Falls, Pa.

STEEL, STRIP AND SHEET
Central Steel Co., Massillon, O.
Driver-Harris Co., Harrison, N. J.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.

STEEL, HIGH SPEED TOOL
Anchor Drawn Steel Co., Latrobe, Pa.
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago.
Boker, H. & Co., Inc., 101 Duane St., New York.
Carpenter Steel Co., Reading, Pa.
Colonial Steel Co., Pittsburgh, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Hawkridge Bros. Co., Boston, Mass.
Ludlum Steel Co., Watervliet, N. Y.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Simonds Saw & Steel Co., Fitchburg, Mass.
Vanadium Alloys Steel Co., Latrobe, Pa.
Vulcan Crucible Steel Co., Aliquippa, Pa.

STEEL, MACHINE
Colonial Steel Co., Pittsburgh, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Hawkridge Bros. Co., Boston, Mass.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Union Drawn Steel Co., Beaver Falls, Pa.
Vanadium-Alloys Steel Co., Latrobe, Pa.
Vulcan Crucible Steel Co., Aliquippa, Pa.

STEEL, RUSTLESS
Carpenter Steel Co., Reading, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.

STEEL, STAINLESS
Carpenter Steel Co., Reading, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.

STELLITE
Haynes Stellite Co., 30 E. 42nd St., New York.

STOCKS, DIE
Armstrong Mfg. Co., Bridgeport, Conn.
Butterfield & Co., Div. Union Twist Drill Co., Derby Line, Vt.
Card Mfg. Co., S. W., Div. Union Twist Drill Co., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Curtis & Curtis Co., 324 Garden St., Bridgeport, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Oster Mfg. Co., Cleveland.
Pratt & Whitney Co., Hartford, Conn.
Reed Mfg. Co., Erie, Pa.
Saunders' Sons, Inc., D., Yonkers, N. Y.
Threadwell Tool Co., Greenfield, Mass.

STONES, OIL
Carborundum Co., Niagara Falls, N. Y.
Norton Co., Worcester, Mass.

STOOLS AND CHAIRS, STEEL
See Furniture, Shop and Drafting-room.

STRAIGHTENING MACHINERY
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Niles-Bement-Pond Co., 111 Broadway, New York.
Shuster Co., F. B., New Haven, Conn.
Springfield Machine Tool Co., 631 Southern Ave., Springfield, O.

STUD SETTERS, OPENING
Errington Mechanical Laboratory, Broadway and John St., New York.
Geometric Tool Co., New Haven, Conn.

SUB PRESSES
Danly Machine Specialties, Inc., 4907 Lincoln Ave., Chicago.
U. S. Tool Co., Inc., Ampere, N. J.

SWAGING MACHINES
Etna Machine Co., Toledo, O.
Langelier Mfg. Co., Arlington, Cranston, R. I.
Torrington Co., Torrington, Conn.

SWITCHBOARDS
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

SWITCHES
Bristol Co., Waterbury, Conn.
General Electric Co., Schenectady, N. Y.
Monitor Controller Co., Baltimore, Md.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

TABLES, CIRCULAR
Cochrane-Bly Co., Rochester, N. Y.

TACHOMETERS
Bristol Co., Waterbury, Conn.
Scherr, George, 143 Liberty St., New York.
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

TAPES, MEASURING
Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Keuffel & Esser Co., Hoboken, N. J.
Starrett Co., L. S., Athol, Mass.

TAP EXTENSIONS
Allen Mfg. Co., Hartford, Conn.

TAP EXTRACTORS
Walton Co., Hartford, Conn.

TAP HOLDERS
National Automatic Tool Co., Richmond, Ind.
Procunier, Wm. L., 18 S. Clinton St., Chicago.

TAPPING ATTACHMENTS AND DEVICES
American Tool Works Co., Cincinnati.
Baker Bros., Inc., Toledo, O.
Barber-Colman Co., Rockford, Ill.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Cincinnati Bickford Tool Co., Oakley, Cincinnati.
Consolidated Machine Tool Corp., Rochester, N. Y.
Eastern Tube & Tool Co., Inc., Brooklyn, N. Y.
Errington Mechanical Laboratory, Broadway and John St., New York.
Geometric Tool Co., New Haven, Ct.
Hoefer Mfg. Co., Freeport, Ill.
Leland-Gifford Co., Worcester, Mass.
Modern Tool Co., Erie, Pa.
Mueller Machine Tool Co., Cincinnati.
National Automatic Tool Co., Richmond, Ind.
Procunier, Wm. L., 18 South Clinton St., Chicago.
Townsend, H. P., Mfg. Co., Hartford, Conn.
Western Mch. Tool Works, Holland, Mich.
Whitney Mfg. Co., Hartford, Conn.

TAPPING MACHINES
Acme Machinery Co., Cleveland.
Baker Bros., Inc., Toledo, O.
Barnes Drill Co., 814 Chestnut St., Philadelphia.
Bench Mch. Tool Co., Philadelphia, Pa.
Economy Engineering Co., Willoughby, Ohio.
Geometric Tool Co., New Haven, Ct.
Greenlee Bros. & Co., Rockford, Ill.
Hoefer Mfg. Co., Freeport, Ill.
Langelier Mfg. Co., Arlington, Cranston, R. I.
Leland-Gifford Co., Worcester, Mass.
Moline Tool Co., Moline, Ill.
Murchey Mch. & Tool Co., 34 Porter St., Detroit, Mich.
National Automatic Tool Co., Richmond, Ind.
National Machinery Co., Tiffin, O.
Procunier, Wm. L., 18 So. Clinton St., Chicago.
Rockford Drilling Mch. Co., Rockford, Ill.
Saunders' Sons, Inc., D., Yonkers, N. Y.
Western Machine Tool Wks., Holland, Mich.

TAPS
Besly & Co., Charles H., 120-B No. Clinton St., Chicago.
Brubaker & Bros. Co., W. L., 50 Church St., New York.
Butterfield & Co., Div. Union Twist Drill Co., Derby Line, Vt.
Card Mfg. Co., S. W., Div. of Union Twist Drill Co., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Geometric Tool Co., New Haven, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hanson-Whitney Mfg. Co., Hartford, Conn.
Landis Machine Co., Inc., Waynesboro, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
National Acme Co., Cleveland.
Pratt & Whitney Co., Hartford, Conn.
Saunders' Sons, Inc., D., Yonkers, N. Y.
Standard Tool Co., Cleveland.
Threadwell Tool Co., Greenfield, Mass.

TAPS, COLLAPSING
Consolidated Machine Tool Corp., Rochester, N. Y.
Errington Mechanical Laboratory, Broadway and John St., New York.
Geometric Tool Co., New Haven, Conn.
Landis Mch. Co., Inc., Waynesboro, Pa.
Modern Tool Co., Erie, Pa.
Murchey Mch. & Tool Co., 34 Porter St., Detroit, Mich.
National Acme Co., Cleveland, O.

THERMOMETERS
American Gas Furnace Co., Elizabeth, N. J.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia.

THERMOMETERS, INDICATING AND RECORDING
Brown Instrument Co., Philadelphia.

THREAD CUTTING MACHINERY
Acme Machinery Co., Cleveland
Automatic Mch. Co., Bridgeport, Conn.
Eastern Machine Screw Corp., New Haven, Conn.
Economy Engineering Co., Willoughby, Ohio.
Fellows Gear Shaper Co., Springfield, Vt.
Ferner Co., R. Y., Washington, D. C.
Geometric Tool Co., New Haven, Ct.
Grant Mfg. & Mch. Co., N. W. Station, Bridgeport, Conn.
H & G Works, Eastern Machine Screw Corp., New Haven, Conn.
Landis Machine Co., Inc., Waynesboro, Pa.
Lees-Bradner Co., Cleveland.
Murchey Mch. & Tool Co., 34 Porter St., Detroit, Mich.
National Acme Co., Cleveland, O.
National Machinery Co., Tiffin, O.
Oster Mfg. Co., Cleveland.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Corp., Brighton, Boston.
Williams Tool Corp., Erie, Pa.

THREAD CUTTING TOOLS
Armstrong Bros. Tool Co., 313 No. Francisco Ave., Chicago.
Oster Mfg. Co., Cleveland.
Ready Tool Co., Bridgeport, Conn.
Rivett Lathe & Grinder Corp., Brighton, Boston.
Williams, J. H., & Co., Buffalo, N. Y.

THREAD GAGES
See Gages, Thread.

THREAD MILLING MACHINES
Consolidated Machine Tool Corp., Rochester, N. Y.
Hall Planetary Company, Philadelphia, Pa.
Hanson-Whitney Machine Co., Hartford, Conn.
Lees-Bradner Co., Cleveland
Newton Machine Tool Works, Inc., Rochester, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Smalley-General Co., Inc., Bay City, Mich.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Waltham Machine Works, Waltham, Mass.

THREAD ROLLING MACHINES
National Machinery Co., Tiffin, O.
Stoll Co., Inc., D. H., Buffalo, N. Y.

THREAD ROLLING MACHINES, SHEET METAL
V & O Press Co., Hudson, N. Y.

TIME RECORDS, WORKMEN'S TIME ON THE JOB
See Recording Instruments for Time.

TIRE MOLD CUTTING MACHINES
Keller Mechanical Engineering Corp., 74 Washington St., Brooklyn, N. Y.

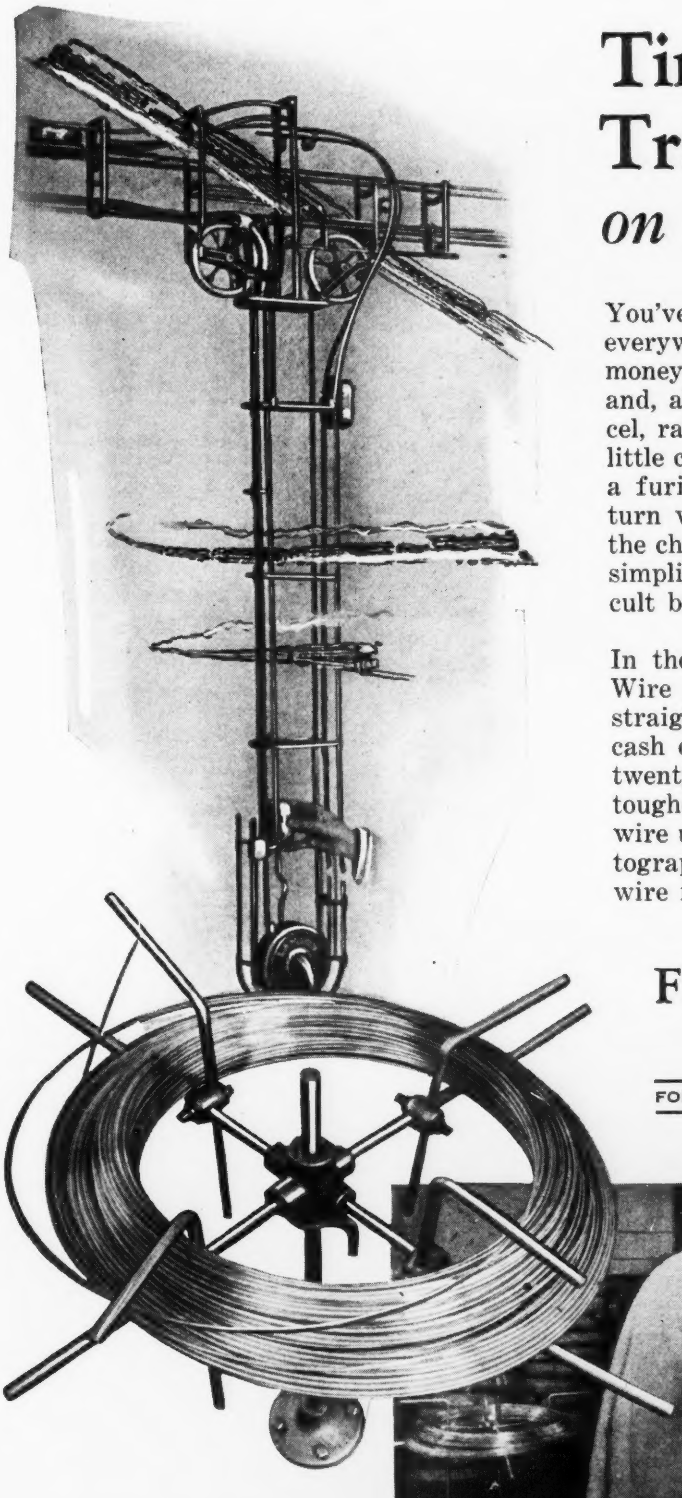
TIRE WELDERS AND BENDERS
Williams, White & Co., Moline, Ill.

TOOL BITS, STELLITE
Haynes Stellite Co., 30 E. 42nd St., New York.

TOOL CASES
Gerstner & Sons, H., Dayton, O.
Starrett Co., L. S., Athol, Mass.

TOOL HOLDER BITS, HIGH SPEED STEEL
Armstrong Bros. Tool Co., 313 No. Francisco Ave., Chicago.
Barber-Colman Co., Rockford, Ill.
Carpenter Steel Co., Reading, Pa.
Colonial Steel Co., Pittsburgh.
Firth-Sterling Steel Co., McKeesport, Pa.
Ludlum Steel Co., Watervliet, N. Y.
Simonds Saw & Steel Co., Fitchburg, Mass.
Vanadium-Alloys Steel Co., Latrobe, Pa.
Williams, J. H., & Co., Buffalo, N. Y.

ALPHABETICAL INDEX OF ADVERTISERS, PAGES 283-284



Tiny Express Trains—*running on a wire railroad!*

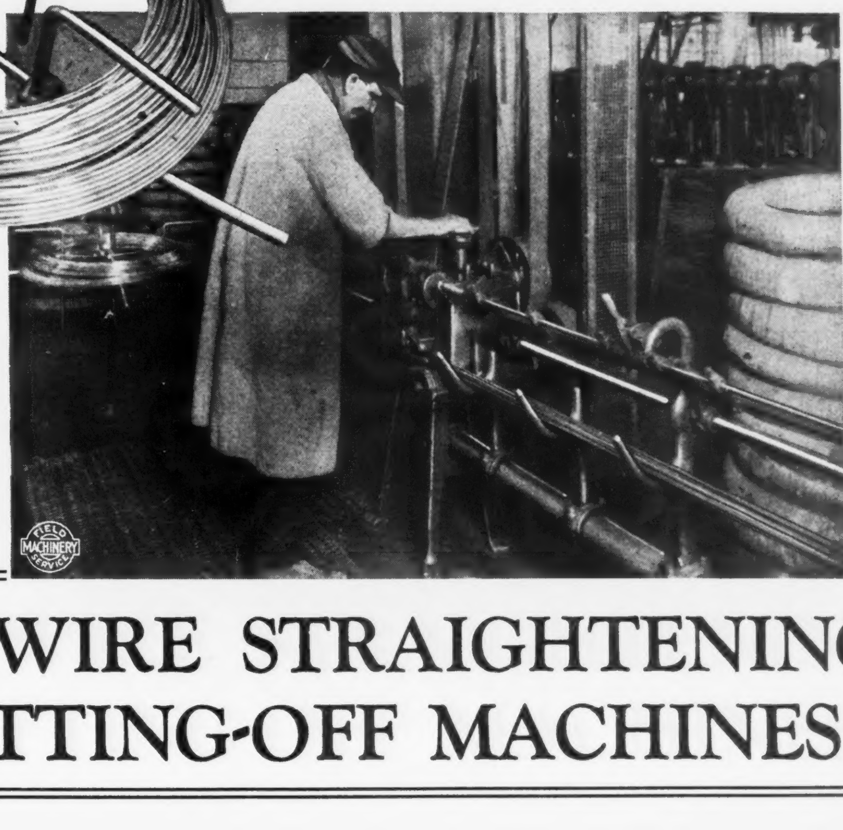
You've seen them. In big department stores everywhere, Lamson Carriers swiftly take your money to some far-away and invisible cashier, and, almost before the clerk can wrap your parcel, race back with your change and receipt. The little cash boxes whisk along the wire runways at a furious pace, taking each sudden right angle turn with unabated speed—not only fascinating the children (and sometimes the grown-ups), but simplifying, centralizing and expediting the difficult business of handling cash.

In the Lamson plant at Syracuse, two Shuster Wire Straightening and Cutting-off Machines straighten and cut-off the wire used in these cable cash carrier systems. These Shuster's have seen twenty-five years of exceptional service on the toughest kind of work—cutting Bessemer steel wire up to 1/4″ in diameter. At the time the photograph was taken this Shuster was cutting 1/4″ wire in 8 feet lengths.

F. B. SHUSTER CO.

NEW HAVEN, CONN.

FORMERLY JOHN ADT & SON ESTABLISHED 1866



If wire is used extensively in your product it will pay you to look into the possibilities of Shuster Wire Straightening and Cutting-Off Machines. May we send our catalog R?

SHUSTER WIRE STRAIGHTENING AND CUTTING-OFF MACHINES

TOOL HOLDERS

Armstrong Bros. Tool Co., 313 No. Francisco Ave., Chicago.
Cleveland Twist Drill Co., Cleveland.
Gisholt Machine Co., 1300 E. Washington Ave., Madison, Wis.
Haynes Stellite Co., 30 E. 42nd St., New York.
Lovejoy Tool Co., Inc., Springfield, Vt.
O. K. Tool Co., Inc., Shelton, Conn.
Osgood Tool Co., J. L., Buffalo, N. Y.
Ready Tool Co., Bridgeport, Conn.
Ruddies, G. F., 747 E. 136th St., New York.
Western Tool & Mfg. Co., Springfield, Ohio.
Williams, J. H., & Co., Buffalo, N. Y.

TOOLS, STELLITE WELDED TIP

Haynes Stellite Co., 30 E. 42nd St., New York.

TORCHES, OXY-ACETYLENE AND OXY-HYDROGEN

See Welding and Cutting, Oxy-Acetylene Equipment.

TRACING CLOTH AND PAPER

Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Keuffel & Esser Co., Hoboken, N. J.

TRACING FILING CABINETS

See Cabinets, Filing.

TRACTORS, INDUSTRIAL

Yale & Towne Mfg. Co., Stamford, Conn.

TRAILERS, INDUSTRIAL

Yale & Towne Mfg. Co., Stamford, Conn.

TRANSFORMERS

General Electric Co., Schenectady, N. Y.
Reliance Elec. & Eng. Co., 1056 Ivanhoe Rd., Cleveland.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

TRANSITS, ENGINEERS

Dietzgen Co., Eugene, 166 W. Monroe St., Chicago.
Keuffel & Esser Co., Hoboken, N. J.
Starrett Co., L. S., Athol, Mass.

TRANSMISSION MACHINERY

See Hangers, Shafting, Pulley, Clutches, Couplings, Belting, Chain, Etc.

TRANSMISSION, VARIABLE SPEED

Oilgear Co., Milwaukee, Wis.
Reeves Pulley Co., Columbus, Ind.

TROLLEYS AND TRAMWAYS

Hanna Engineering Works, 1763 Elston Ave., Chicago.
Roeper Crane & Hoist Works, Reading, Pa.
Wright Mfg. Co., Lisbon, O.
Yale & Towne Mfg. Co., Stamford, Conn.

TRUCKS, INDUSTRIAL

Angle Steel Stool Co., Plainwell, Mich.
Yale & Towne Mfg. Co., Stamford, Conn.

TUBE EXPANDERS

Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Watson-Stillman Co., 192 Fulton St., New York.

TUBING, FLEXIBLE

Roller Bearing Co. of America, Newark, N. J.
Wheelock Mfg. Co., Wheelock, Vt.

TUBING, SEAMLESS STEEL

National Tube Co., Pittsburgh.

TUBING, STEEL

National Tube Co., Pittsburgh.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.

TUMBLING BARRELS

Abbott Ball Co., Elmwood, Hartford, Conn.
Baird Mch. Co., Bridgeport, Conn.
Globe Mch. & Stamping Co., 1255 W. 76th St., Cleveland, O.
Royersford Fdry. & Mch. Co., 54 N. 5th St., Philadelphia.

TURBINES, STEAM

General Electric Co., Schenectady, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Whiton, D. E., Mch. Co., New London, Conn.

TURNTABLES

Canton Fdry. & Mchy. Co., Canton, O.
Link-Belt Company, Chicago.

TURRET ATTACHMENTS

McCrosky Tool Corp., Meadville, Pa.
Meisselbach-Catucci Mfg. Co., Newark, N. J.

TURRET LATHES, VERTICAL

Bullard Machine Tool Co., Bridgeport, Conn.
Niles-Bement-Pond Co., 111 Broadway, New York.

TWIST DRILLS

See Drills, Twist.

UNIONS

Dart Mfg. Co., E. M., Providence, R. I.

UNIVERSAL JOINTS

Boston Gear Wks., Sales Co., Norfolk Downs, Quincy, Mass.

VALVE LEATHERS

Chicago Rawhide Mfg. Co., 1309 Elston Ave., Chicago.

VALVES, HYDRAULIC

Elmes Engineering Works, Charles F., 222 North Morgan St., Chicago.
Hydraulic Press Mfg. Co., Mt. Gilead, Ohio.
Watson-Stillman Co., 192 Fulton St., New York.

VENTILATING APPARATUS

Buffalo Forge Co., Buffalo, N. Y.
General Electric Co., Schenectady, N. Y.

VISES AND CLAMPING DEVICES, AIR OPERATED

Logansport Mch. Co., 529 Market St., Logansport, Ind.

VISES, BENCH

Fulton Drop Forge Co., Canal Fulton, Ohio.
New Britain Machine Co., New Britain, Conn.
Reed Mfg. Co., Erie, Pa.
Western Tool & Mfg. Co., Springfield, O.
Yost Mfg. Co., Meadville, Pa.

VISES, MACHINE

Armstrong Bros. Tool Co., 313 No. Francisco Ave., Chicago.
Barber-Colman Co., Rockford, Ill.
Brown Engineering Co., 133 No. Third St., Reading, Pa.
Cochrane-Bly Co., Rochester, N. Y.
Graham Mfg. Co., Providence, R. I.
LeBlond, R. K., Machine Tool Co., Cincinnati.
Logansport Mch. Co., 529 Market St., Logansport, Ind.
Martin Tool & Die Works, J. E., Springfield, O.
Skinner Chuck Co., New Britain, Conn.
Thomas Elevator Co., 24 So. Hoyne Ave., Chicago.
Whitney Mfg. Co., Hartford, Conn.
Yost Mfg. Co., Meadville, Pa.

VISES, PIPE

Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Machine Works, Edwardsville, Ill.
Butterfield & Co., Div. Union Twist Drill Co., Derby Line, Vt.
Curtis & Curtis Co., 324 Garden St., Bridgeport, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Reed Mfg. Co., Erie, Pa.
Saunders' Sons, Inc., D., Yonkers, N. Y.
Williams, J. H. & Co., Buffalo, N. Y.
Yost Mfg. Co., Meadville, Pa.

VISES, PLANER AND SHAPER

American Tool Works Co., Cincinnati.
Cincinnati Planer Co., Cincinnati.
Hendey Mch. Co., Torrington, Conn.
Skinner Chuck Co., New Britain, Conn.

VISES, UNIVERSAL MACHINE

Barber-Colman Co., Rockford, Ill.
Boston Scale & Mch. Co., Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Brown Enginering Co., 133 No. Third St., Reading, Pa.
Graham Mfg. Co., Providence, R. I.
Skinner Chuck Co., New Britain, Conn.

VISES, UNIVERSAL WOODWORKERS'

Yost Mfg. Co., Meadville, Pa.

VOLTMETERS

Bristol Co., Waterbury, Conn.
General Electric Co., Schenectady, N. Y.

WASHER MACHINERY

National Machinery Co., Tiffin, O.

WASHERS

Globe Machine & Stamping Co., 1255 W. 76th St., Cleveland, O.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.
Wilmington Fibre Specialty Co., Wilmington, Del.

WASHERS, LEATHER

Chicago Belting Co., 127 N. Green St., Chicago, Ill.
Chicago Rawhide Mfg. Co., 1309 Elston Ave., Chicago.
Schieren Co., Chas. A., 73 Ferry St., New York.

WASHERS, SPACING

See Collars, Spacing, etc.

WASHING MACHINES, METAL PARTS

Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.

WELDING AND CUTTING, JOB

Globe Machine & Stamping Co., 1255 W. 76th St., Cleveland, O.
Thomson Electric Welding Co., Lynn, Mass.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Winfield Electric Welding Mch. Co., Warren, O.

WELDING EQUIPMENT ELECTRIC ARC

General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

WELDING MACHINES, ELECTRIC BUTT

Federal Machine & Welder Co., Warren, O.
Thomson Electric Welding Co., Lynn, Mass.
Winfield Electric Welding Mch. Co., Warren, O.

WELDING MACHINES, ELECTRIC SPOT

Acme Electric Welder Co., Los Angeles, Cal.
Federal Machine & Welder Co., Warren, O.
Taylor Welder Co., Warren, O.
Thomson Electric Welding Co., Lynn, Mass.
Winfield Electric Welding Mch. Co., Warren, O.

WIRE-NAIL MACHINERY

National Machinery Co., Tiffin, O.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago.

WIRE STRAIGHTENERS AND CUTTERS, AUTOMATIC

Shuster Co., F. B., New Haven, Conn.

WIRE WORKING MACHINERY

Baird Machine Co., Bridgeport, Conn.
King, R. D., 1620 Monadnock Block, Chicago.
Shuster Co., F. B., New Haven, Conn.

WOOD SCREW MACHINERY

Townsend, H. P., Mfg. Co., Hartford, Conn.

WOOD WORKING MACHINERY

Crescent Machine Co., 56 Main St., Leetonia, O.
New Britain Machine Co., New Britain, Conn.
Sidney Machine Tool Co., Sidney, O.
Wappat Gear Wks., Pittsburgh, Pa.

WRENCHES

Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago.
Armstrong Mfg. Co., Bridgeport, Conn.
Coes Wrench Co., Worcester, Mass.
Greene, Tweed & Co., 100 Duane St., New York.
Standard Tool Co., Cleveland.
Threadwell Tool Co., Greenfield, Mass.
Williams, J. H., & Co., Buffalo, N. Y

WRENCHES, PIPE

Greene, Tweed & Co., 109 Duane St., New York.
Greenfield Tap & Die Corp., Greenfield, Mass.
Reed Mfg. Co., Erie, Pa.
Williams, J. H., & Co., Buffalo, N. Y.

WRENCHES, RATCHET

Greene, Tweed & Co., 109 Duane St., New York.
Starrett Co., L. S., Athol, Mass.
Williams, J. H., & Co., Buffalo, N. Y.

WRENCHES, TAP

Besly & Co., Charles H., 120-B No. Clinton St., Chicago.
Brubaker & Bros., Co., W. L., 50 Church St., New York.
Butterfield & Co., Div. Union Twist Drill Co., Derby Line, Vt.
Card Mfg. Co., S. W., Div. of Union Twist Drill Co., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Greenfield Tap & Die Corp., Greenfield, Mass.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
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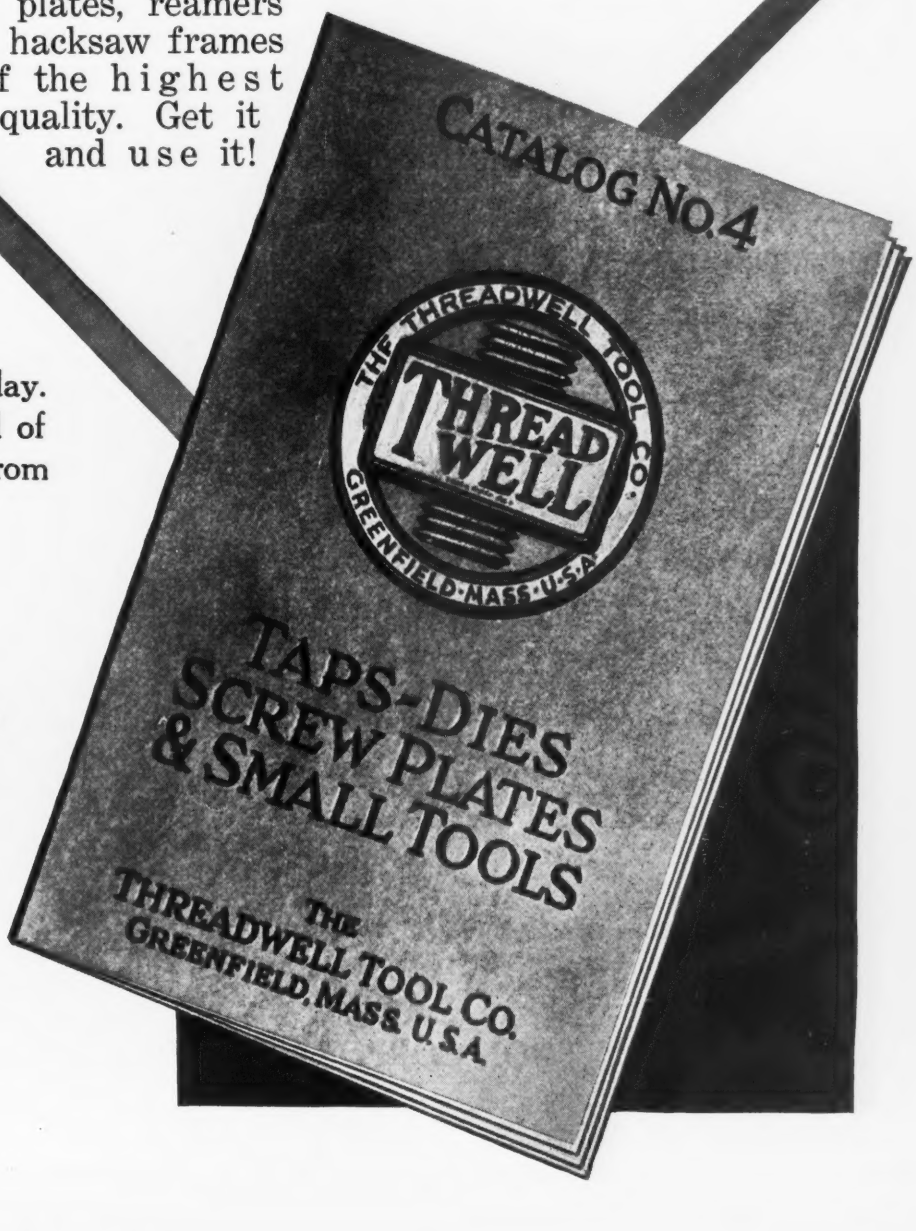

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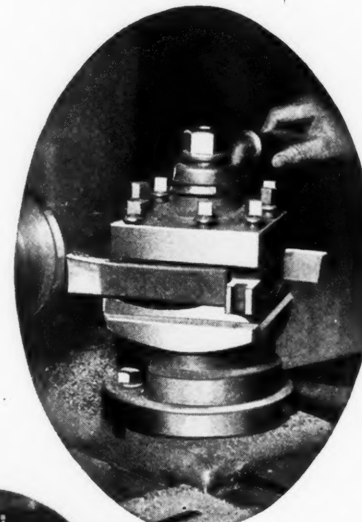

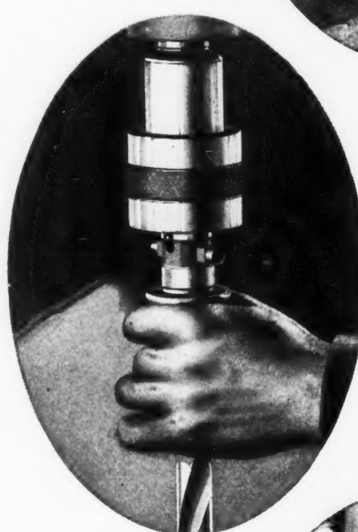

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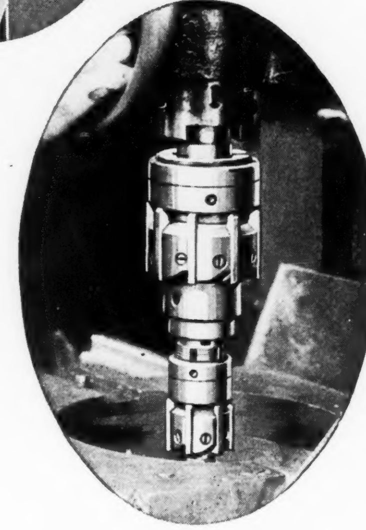

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